OBSOLESCENCE REDUCTION THROUGH
ASSEMBLE-TO-ORDER:
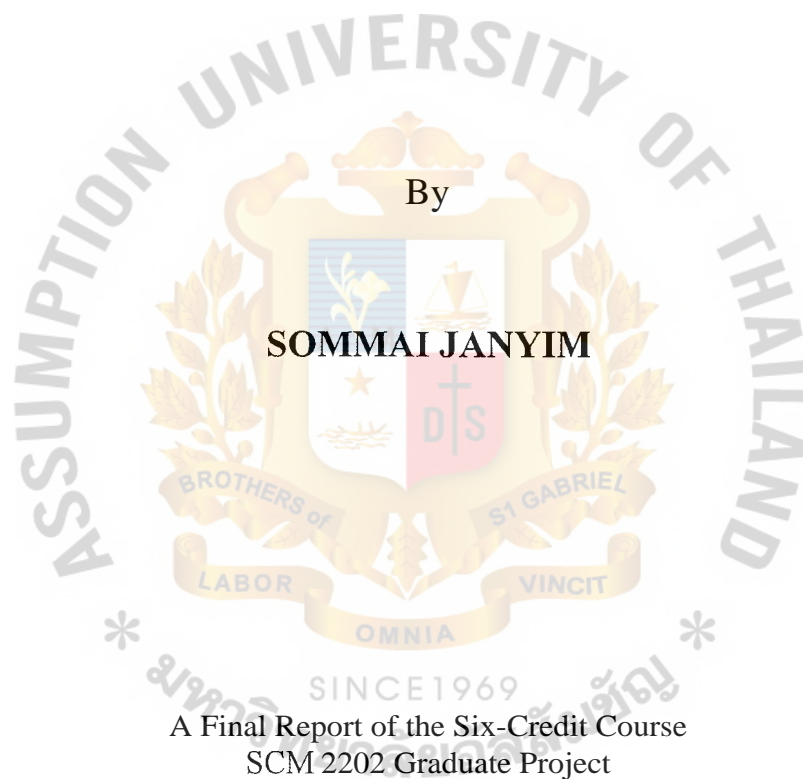A CASE STUDY OF AN OPTICAL COMPANY

By

SOMMAI JANYIM

A Final Report of the Six-Credit Course
SCM 2202 Graduate Project

Submitted in Partial Fulfillment of the Requirements for the Degree of
MASTER OF SCIENCE IN SUPPLY CHAIN MANAGEMENT

Martin de Tours School of Management
Assumption University
Bangkok, Thailand

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October 2010

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Martin de Tours School of Management

Master of Science in Supply Chain Management

Form signed by Proofreader of the Graduate Project

I, <u>Asst. Prof. Brian Lawrence</u>, have proofread this Graduate Project entitled

<u>Obsolescence Reduction through Assemble-to-Order: A Case Study of an Optical Company</u>

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<u>Mrs. Sommai Janyim</u>

and hereby certify that the verbiage, spelling and format is commensurate with the quality of internationally acceptable writing standards for a master degree in supply chain management.

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Assumption University
Martin de Tours School of Management
Master of Science in Supply Chain Management

Declaration of Authorship Form

I, Ms. Sommai Janyim declare that this thesis/project and the work presented in it are my own and has been generated by me as the result of my own original research.

[Title of thesis/project] Obsolescence Reduction through Assemble-To-Order

I confirm that:

1. This work was done wholly or mainly while in candidature for the M.Sc. degree at this University;

2. Where any part of this dissertation has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;

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I confirm that this thesis/project has been carried out under my supervision and it represents the original
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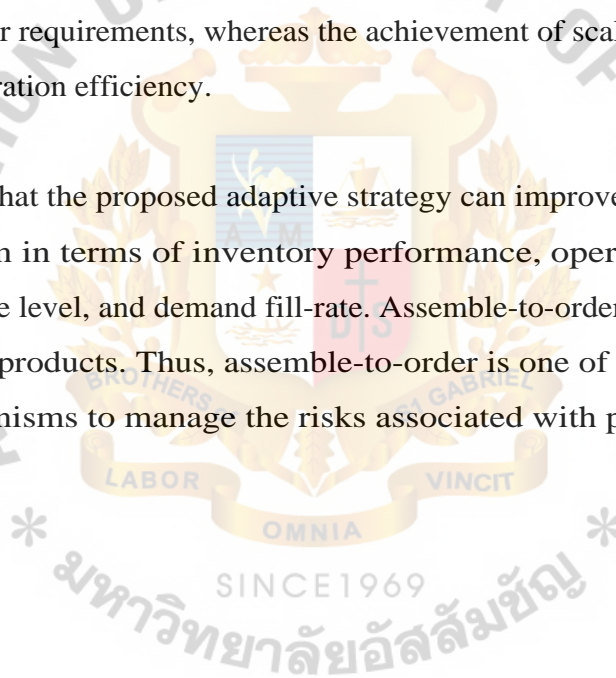Advisor

Date

December 23, 2010

ABSTRACT

This project deals with a proposed alternative solution to the existing model, in order to prevent inventory cost due to obsolescence, which is currently a crucial problem for the firm.

Assemble-to-order refers to a supply chain strategy in which products are not assembled until a customer order arrives. It is delayed until the point of product differentiation. This strategy has have two main dimensions, which are responsiveness and achievement level of scale economies. Responsiveness refers to the capability of fulfilling customer requirements, whereas the achievement of scale economies reflects the degree of operation efficiency.

Results indicate that the proposed adaptive strategy can improve the performance of the supply chain in terms of inventory performance, operation, lead time of production service level, and demand fill-rate. Assemble-to-order can be embodied in a variety of end products. Thus, assemble-to-order is one of the most beneficial strategic mechanisms to manage the risks associated with product variety and uncertain sales.

ACKNOWLEDGEMENTS

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CHAPTER I

GENERALITIES OF THE STUDY

Currently, inventory management decisions are very important in the supply chain function because customers have become very demanding, and it is necessary to maintain a high level of customer service and to increase the efficiency of inventory performance at the same time. In today's business environment inventory management is more challenging, and usually involves selection of an overall strategy from a range of alternatives. As inventory decision-making becomes more complex, firms have placed more pressure on themselves to consider the nature of the demand, product life cycle, product variety, and market standards for lead times and service level. Managing inventories more effectively should lower the cost and improve the service as well. Thus, the firm monitors inventory levels, production schedules and purchases, so as to meet the current service level.

Looking at the relevant literature, we can note that supply chains can basically be classified into three main types according to the degree of interaction with the market. One can distinguish between Make-to-stock (MTS), Assemble-to-order (ATO) and Make-to-order (MTO). Whereas make-to-stock work on the basis of an anticipatory model in which end products are manufactured according to forecast, the make-to-order system involves the highest degree of close interaction with the market to meet the customer's requirements. Because all manufacturing stages are not initiated until a customer order arrives, the assemble-to-order type is situated between these two extremes and represents a model for which parts and subassemblies are made to forecast while the assembly of end products is delayed until customer orders have been received (Wemmerlov, 1984).

Consequently, the inventory model of make-to-stock mainly works according to the forecast. If the forecast is uncertain, when supply exceeds the demand a product has to be marked down in price; the firm might have increased inventory costs, such as obsolescent stock or excess or the carrying inventory cost. Make-to-order involves the

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highest degree of interaction with the market. There is a high risk of lost sale opportunities and customer dissatisfaction. Because customers have to wait a long lead time for production of the products, the company cannot fulfill their desired service level to customer.

Hence, the aim of this study is to propose assemble-to-order (AT0), situated between the MTS and MTO model extremes, which represents a hybrid model in which parts and subassemblies are made to forecast while the assembly of end products is postponed until a customer order arrives.

This study will focus on the application of ATO to an optical company for managing inventories. This proposal prevents obsolescence inventory cost, carrying inventory cost, and reduces the number of items to manage in the inventory.

1.1 Background of the Company

The Optical company group has 15 plants worldwide that produce 215 million optical lenses corresponding to 300,000 products list references in 2008.

Figure 1.1: Plants and Laboratories
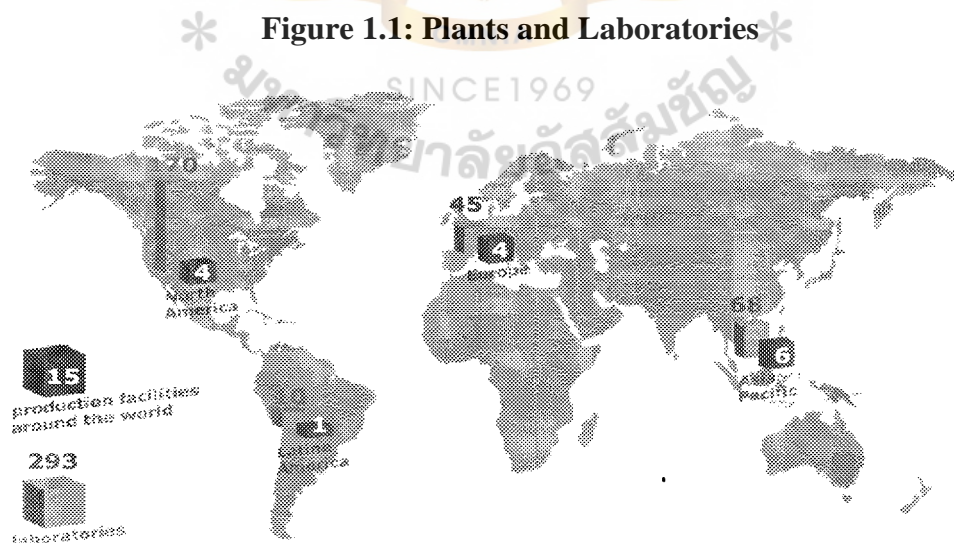
Source: Optical Company worldwide Marketing department (2008 figures)

Figure 1.1 represent the laboratories to service customer. The total is 293 laboratories around the word, and production facilities also have 15 plants around the world. The biggest production plant is an optical company located near Bangkok established to produce optical lenses for export to markets in Europe, America and Asia.

`Optical Company (Thailand)' (a pseudonym) was formed in 1990 and has a twenty-year history of providing optical lenses (plastics lenses) and around 2,200 employees. The production facilities have to produce more than fifty million optical lenses per year using several materials such as Organic optical lenses and Polycarbonate optical lenses, with all the type of surface treatments that exist: scratch resistant coating, thin able coatings, and anti-refection coatings.

In the year 2000, an expansion of the factory was constructed for a new product for Polycarbonate as high-tech optical lenses to meet the demand of customers, as shown in Figure 1.2. These products also experience significant growth in the market, so this product is in a growth market for high-tech optical lens.

Figure 1.2 : The Growth of Product Group

Source: Optical Company worldwide Marketing Department

Important Product: Hard Multicoated Optical Lens

The mass production manufacture is the complete corrective range which is finished single vision. The Optical company's products divide into two main groups: 1) High Tech optical lenses 2) Standard optical lenses, as depicted in Table 1.1.

Table 1.1 : Sales Volume by Products Group, year 2009

Material	Characteristic	High Tech Optical lens	Standard Optical lens
Organic Optical Lenses	Sale Volume	6 million lenses	20 million lenses
	Number Items	21,000 items	48,000 items
	Uncoate		Standard optical lens
	Hard coated (HC)		Standard optical lens
	Hard Multicoated (HMC)	High tech optical lens	
Polycarbonate Optical Lenses	Sale Volume	16 million lenses	10 million lenses
	Number Items	42,000 items	18,000 items
	Hard coated (HC)		Standard optical lens
	Hard Multicoated (HMC)	High tech optical lens	

Source: Optical Company Supply Chain Department

Table 1.1 shows the highest sale volume for Polycarbonate hard multicoated high tech optical lenses, with 16 million lenses per year, and Organic high tech optical lenses with 6 million lenses. The number of items for Polycarbonate product is 42,000 items, and Organic has 21,000 items.

The added value of the optical business is to apply high technology to the products. The Optical Company has an infinite number of combinations to satisfy every customer's need, such as to increase high tech products to customers. Figure 1.3 represents the added value of the optical lenses such as Thin, Anti-UV protection, Anti-smudge and dust, and Glare reflection, in the multicoated function.

Figure 1.3 : The Added value of optical lenses
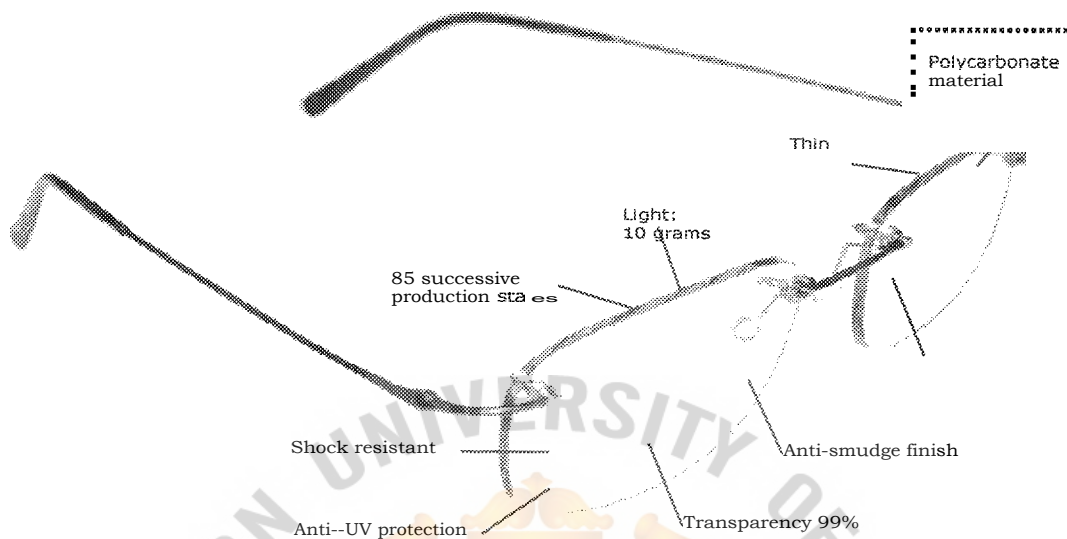
Source: Optical Company worldwide R&D Department

The optical company has always offered product varieties in the market, especially high tech optical lenses (the technology of the visible). Their greatest asset is to enable customers wearing eyeglasses to see the world better. The growth of the final product is an alternative solution for customers. This means that inventory and production process are integrated ready to deliver to customers with a shorter lead time, therefore the Optical Company has three categories in its delivery network which follow the characteristic of customers' businesses:

- Factory delivery to Factory
- Factory deliver to Distribution Center (three main distribution Centers: Thailand, France and United State of America)
- Factory deliver to Laboratories (Subsidiary)

Business Process and Work process of the Optical Company:

The Optical company has its main activities and integration among department. The major work processes include the management process, value chain process and support process (show in Figure 1.4).

Figure 1.4 : Business process and work process
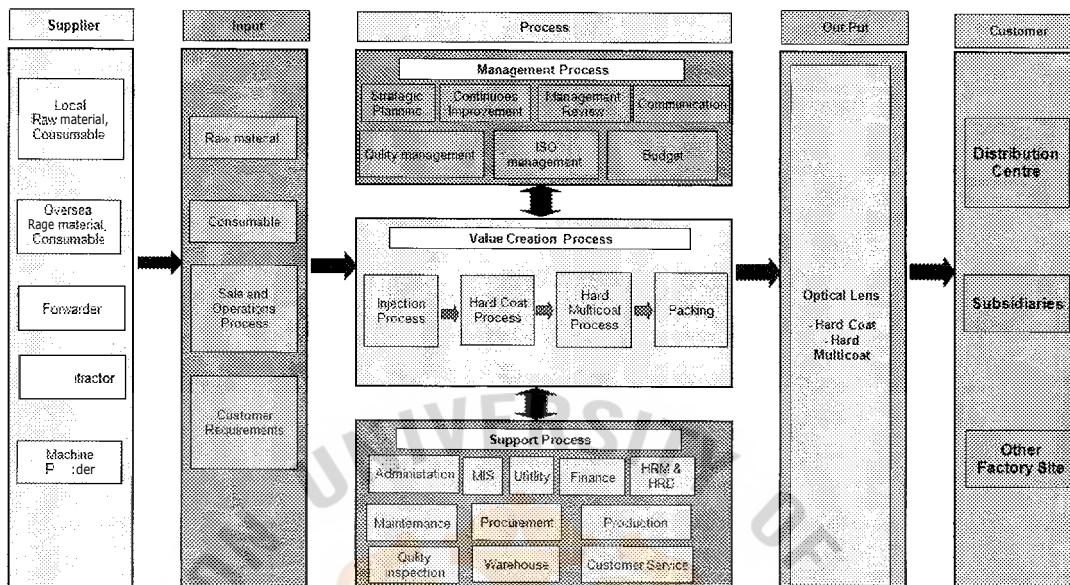
Source: Optical Company Continue Improvement Department

The optical company operates a business in which each department operates individually. Figure 1.5 depicts the Organization Chart: Financial Department, Supply Chain Department, Production Department, Human Resource Department, and other departments.

The Supply Chain Department (SCD) has responsibility and authority to improve inventory performance and increase sale volume, information technology support, new flow, and new product management. Distribution center planners are involved in manufacturing planning and operations, through controlling and following the inventory level policy.

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Figure 1.5 : Organization Chart of the Optical Company
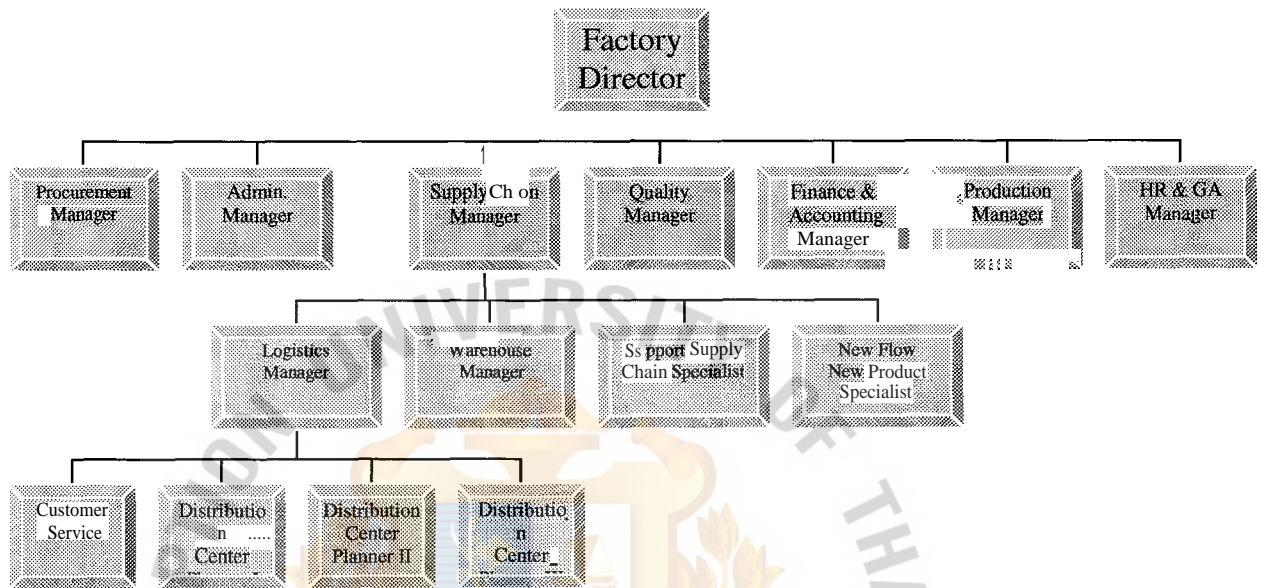
Source: Optical Company

The logistics section is under the Supply Chain Department organization, while more challenging activities such as inventory management are controlled by the distribution center planner with the responsibilities below:

Demand planning is as follows:

- Determination of demand in each time period & translate the priority plan into plans required at plant level (weekly & monthly)
- Have Master planning
- Have Material requirement planning

Capacity management is as follows:

- Determination of resources needed to meet priority plan
- Select methods to make that capacity available, with controlling and monitoring output

Inventory management is as follows:

- Challenge the existing inventory control strategy

- Provision calculations follows the corporate finance manual with result analysis
- Control of inventory level and follow-up policy

Customer Service is as follows:

- Provide support to the sales team, ensuring all sales and service objective are met
- Manage the needs/requirements of high revenue commercial accounts
- Information Technology support
- Develop and implement a new ERP system for order management invoicing flow

1.2 Statement of the Problem

Currently, the Optical Company delivers the finished goods direct from the inventory by the strategy of Make-To-Stock, to provide a wide range of service to all customers and provide a desired high service level (the service level target is 99 %). To anticipate customer requirement it needs sufficient safety stock inventory based on the inventory target; that is assigned from management for around three months coverage of sales forecast to protect against possible stock-out.

Consequently, it generates a need to manufacture based on forecast. When the forecast has uncertainty, a problem is created for the next point. Product variety and complexity of items become difficult to manage and also inventory management, and non-value processes in production will be created with inventory cost for work in process. Finally the obsolescence inventory increases.

1.2.2 The product variety

Regarding the product, Polycarbonate is quite a trend in the market, and in order to provide a wide range of service to all customers, one key is fast delivery for the diversity of customer needs and the growth of product complexity. The researcher therefore focuses on the Polycarbonate product. Consequently product complexity is as depicted by Figure 1.6. This shows the complexity of product HC and HMC, with

growth in the year 2009 to 57,909 items, representing HMC as approximately 43,494 items, but HC with approximately 14,415 items. The example matrix of items is shown in Appendix A.

Figure 1.6: The growth of complexity
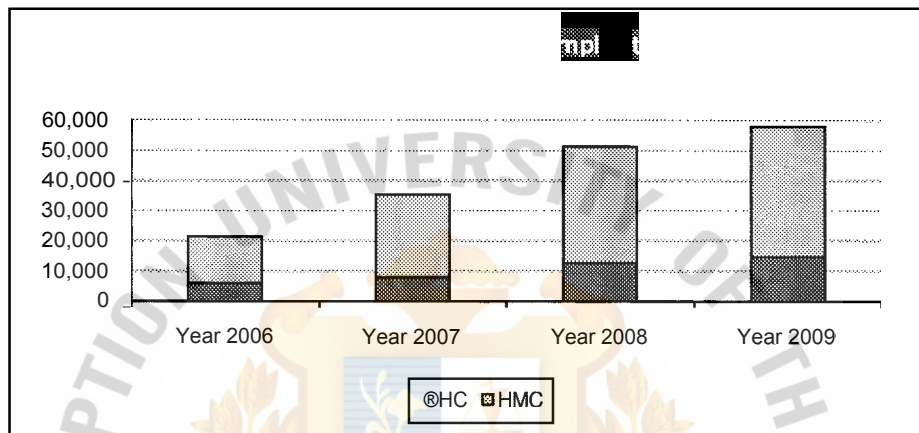
Source: Optical Company's supply chain department

1.2.3 Non value added time

Regarding Figure 1.7: the Optical Company supply chain value stream mapping found that product HMC was 8 days, HC was 6 days, and the process was customized from the starting point until the hard coat process. For HMC product the specific processes are the cleaning process and multicoated process, so the common process is from the starting point till the hard coat process.

Blecker, Thrsten, abdelkafi and Nizar (2006) presented the customization process as being initiated after the customer order arrives. The necessary components are picked out from stock and combined in the main assembly line into the customized products before being shipped to the customer.

Figure 1.7: Optial Company Supply Chain Value Stream Mapping
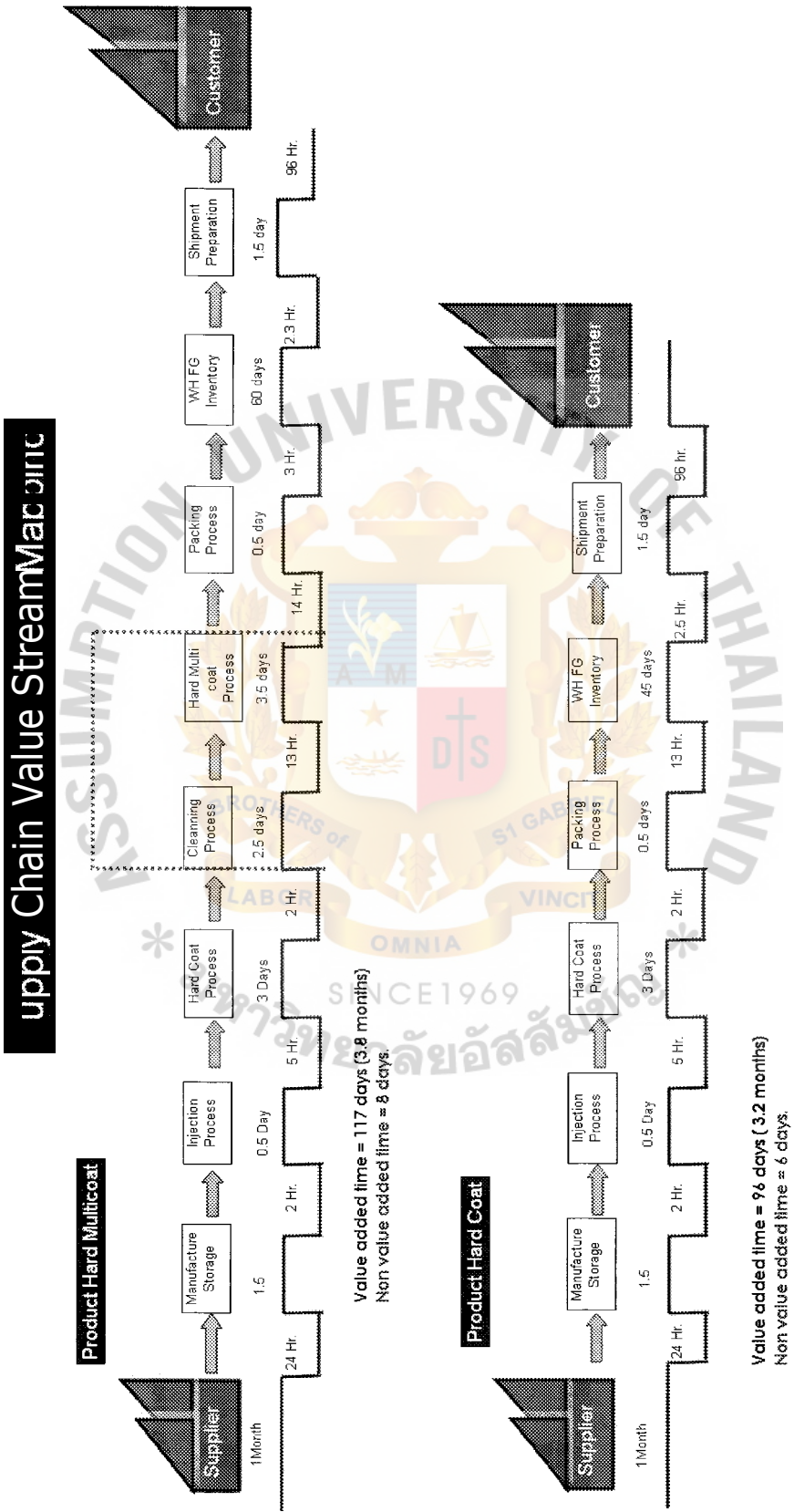
Source: Optical Company's continue improvement department

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1.2.4 Obsolescent inventory

As mentioned, the Optical Company delivered the goods directly from all the inventory items by the MTS strategy, so Figure 1.8 represents the obsolescent inventory trend.

Figure 1.8: Obsolescent Inventory
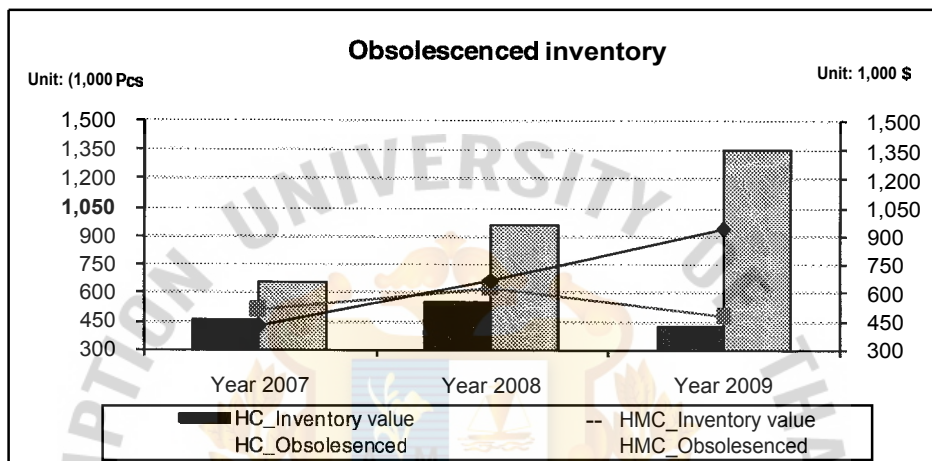
Source: Optical Company's supply chain department

The inventory trend of hard multicoated lens has increased since the year 2007 until the year 2009, with inventory costs of 1.3 million dollars in the year 2009. For hard coated lens from year 2007 till year 2008 inventory increased, but in year 2009 the decreased obsolesces inventory cost was 0.45 million dollars

1.2.5 Inventory policy

As mentioned in the statement of problem, the Optical Company is encountering an inventory problem with Excess inventory by the MTS strategy. Otherwise, the inventory policy to keep safety stock is calculated by this formula:

Formula used

A, B class:	SS = 2*Stdev(sales)*sort(R+LT) + **X*Average(sales)*LT**
C Class:	SS = **X*Averaoe(sales)**

Stdev(sales):	std deviation based on 6 months history
Average(sales):	average of the next 6 months forecasts
R:	Revision period of production programm (=0.25)
LT:	Lead time from production, in months (=0.75)

Note :Policy **Stock coverage** = **X*Average(Month sale)**

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Safety stock calculation was based on the historical sales for the last six months and the average sales of the next six months. The demand uncertainty or error demand forecasting, and products' shelf life, all affect the trend of obsolescence.

Table 1.2: Safety stock calculations

Code	Monthly sale by sku's	% class	% accumualate class	Class	History of last 6 months						STD	SS Computation	Safety stock	Policy stock coverage
					OCT08	NOV08	DEC08	JAN09	FEB09	MAR09				
X-0100-00000	6346	0.33%	0.33%	▨	5554	6587	8203	7743	6209	3741	1605.61	4402	6346	1
x-0200-00000	6259	0.33%	0.66%		7646	5456	10225	6287	4580	3318	2439.95	6054	6259	1
xxxxxxx	xxx	xxx	xxx											
xxxxxxx	xxx	xxx	xxx											
xxxxxxx	)oo(	xxx	xxx											
x-0050-05000	1770	0.09%	20.05%		1457	2130	2162	1973	2015	1030	453.09	1239	2655	1.5
x-0025-05000	1767	0.09%	20.14%		2504	758	1408	1780	2399	1696	647.18	1626	2651	1.5
x-0700-00000	1764	0.09%	20.23%		5124	485	1166	1245	1971	539	1737.55	3528	2646	1.5
xxxxxxx	MO(	xxx	xxx											
xxxxxxx	xxx	xxx	xxx											
xxxxxxx	xxx	xxx	xxx	▨										
x-0450-20000	204	0.01%	83.58%		93	283	340	186	226	54	109.61	477	510	2.5
x-0475-15000	204	0.01%	83.59%		77	198	289	164	405	54	132.41	568	510	2.5
xxxxxxx	xxx	xxx	xxx	0.										
xxxxxxx	)oo(	)0C(	xxx											
xxxxxxx	xxx	)ooC	100.00%											

Source: Optical Company's supply chain department

From to Table 1.2, safety stock calculations are based on the ABC classification, with the historical data of actual sales and stock coverage policy per class. Examples are that class A is one month of sale forecast; class B is 1.5 month of sale forecast, and class C is 2.5 months of sale forecast, and then the inventory is filled according to the defined safety stock level.

The excess inventory might be created if the forecast has fluctuations and there is volatility of customer demand and products. The inventory performance shows in Figure 1.9 the inventories cost and inventory turn, based on products. The key point is that the hard multicoated product is higher than the hard coated product for inventory turn at the last quarter in year 2009 by around 3 months (90 days) for HMC, but for the HC product is 2 months. If the inventory turn for HMC can be decreased through optimizing safety stock, the cost of inventories will be decreased, which can reduce the risk of obsolescence in HMC products, to balance the inventory cost by increasing safety stock on the component items (HC) instead. However inventory investment will be decreased also, because the cost of the HC product is less than HMC.

Figure 1.9: Inventory cost and Inventory turn
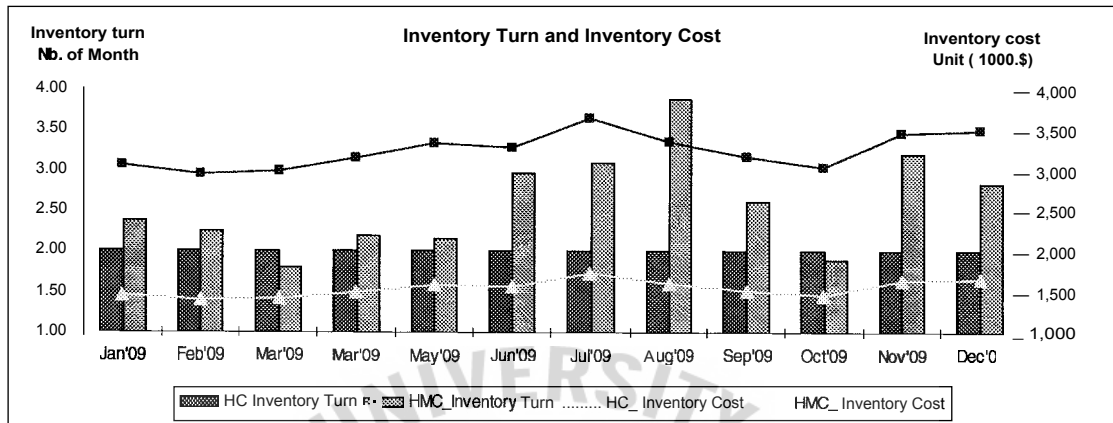
Source: Optical Company's finance department

Managing inventories involves a variety of problem types. Managing inventories cannot be handled using a single solution method. We assume that the conditions of demand level and its variability, lead time and its variability and inventory related costs are known. The supply directly to demand as it occurs is to eliminate inventory by reducing obsolescent inventory.

Consequently, the inventory strategy model of Make-to-stock (MTS) is to balance the level of inventory against the level of service to customers. On the other hand, there is a high risk of increased obsolescence of the final product (Hard multicoated products) in the firm, due to demand fluctuation and phased-out products.

Regarding the trend of product growth, it is opportunity-cost efficient, so the researcher proposes a new model comparing the cost of obsolescence, optimized number of items in inventory management, and the advantages and disadvantages of both inventory strategy models. This project offers better service at lower cost to support the key positioning of this optical company.

In this project, the researcher would like to propose an alternative solution for the inventory strategy from MTS to ATO (Assemble-to-Order). This proposal decreases obsolescence in the final products and increases cost saving through the ATO model.

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The researcher will focus on the final product Polycarbonate Hard Multicoated, as mentioned above.

1.3 Research Questions

The primary research question of this paper is: "Is assemble-to-order suitable to prevent obsolescence inventory cost?"

The secondary research questions are: "What are the benefits of the assemble-to-order inventory model?" If the proposed model gives a better performance, by how much could the firm improve its inventory performance?"

1.4 Research Objectives

The objectives of the study are as follows:

1) To study the different inventory strategy models
2) To propose the ATO model (Assemble-to-Order) for the inventory strategy, to prevent obsolescence inventory cost
3) To determine the advantages and disadvantages in a comparison of the MTS and ATO models in terms of cost, and operational efficiency in comparison with the existing practice according to the inventory management principle.

1.5 Scope of the study

This project is focuses on the finished single-vision Polycarbonate hard multicoated product. The require data is the sale volume of this product in each month, the inventory of each period, and the obsolescence cost from historical data for January 2009 to December 2009. The historical data is collected by interview, collection of documents, and data analysis and all the data obtained is applied to the inventory

management model by proposing an ATO model of inventory management and comparing it with the existing model, using Microsoft Excel Spread Sheet as a tool.

1.5 Limitation of Research

This research focuses mainly on 80% of obsolescence inventory cost, as it cannot cover all product items, because of the huge number of items in the firm. The researcher attempts a particular solution to the problem of high obsolescence inventory.

1.6 Significance of the Study

The significance of the study is that it uses opportunity for studying demand characteristics and finding a suitable ATO inventory system, to be utilized which optimizes the value of the company and maximizes customer service. It is based on a real case and could benefit anyone involved with inventory management in an organization. The number of items will be decreased by using ATO. The study will also give the researcher an opportunity to improve the firm's performance, while gaining more understanding of the supply chain management concept throughout the firm.

1.7 Definition of terms

ABC Classification: The classification of a group of items in decreasing order of annual dollar volume. This array is then split into three classes, called A, B and C.

Assemble-to-Order (ATO): The product is made from standard components that the manufacturer can inventory and assemble according to need, with inventory held ready for assembly.

Hard coated optical lens (HC): Optical lens one-step coating process.

Hard multicoated optical lens (HMC): Optical lens multicoated processes depend on the high technology of the product.

Item: A single type of product which is kept in stock.

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Laboratories: In this study they are subsidiary companies.

Make to Order (MTO): Focuses on the demand management activities, and a positive finished goods inventory is maintained which is used to fill arriving orders.

Make to Stock (MTS): A production environment where goods or services can be made after receipt of a customer's order. Where options or accessories are stocked before customer orders arrive, the tern assemble-to-order is frequently used.

Obsolescence Inventory: Inventory items that have met the obsolescence criteria established by the organization. Obsolete inventory will never be used, or sold at full value. Disposing of the inventory may reduce a company's profit.

Organic optical lens: Optical lens produced by chemicals.

Polycarbonate optical lens: Optical lens produce by resin material.

Safety stock: A quantity of planned to-be in inventory to protect against fluctuation in demand or supply.

Service Level: The customer service level or items fill rate, achieved by a particular inventory policy, the service level target defines by a percentage which they should achieve and the measurement of the inventory management performance.

Stock: All Finished goods and materials stored in an organization which is kept for future demand.

Supply Chain Department (SCD): The department which designs the inventory management strategy to control the inventory level, and the service level in the company of this study.

Uncoated optical lens: Optical lens non coating process.

CHAPTER II

LITERATURE REVIEW

In this chapter, the researcher discusses related literature dealing with the concepts of managing inventory and inventory complexity. Aiming to minimize the obsolescence inventory and delivery reliability are the keys to inventory management, and thus are also covered in this literature review.

The researcher searched through a variety of literature in order to understand the theory and factors of each model relating to cost and customer service requirement. These are necessary to develop the conceptual framework of the project focused on inventory management, and its classification of inventory systems. Also included are: ATO inventory management, MTS inventory management, slow or moving inventory management, Inventory turn, Information sharing and Cross functional.

2.1 Inventory Management

Inventory Management covers a wide variety of activities which vary from organization to organization. Inventory is a stock item kept by an organization as a buffer to cope with uncertainty in customer demand. Other reasons to hold inventory are: reducing the risk of supplier failure or uncertainty, protecting against lead time uncertainty, smoothing seasonal or cycle demand, protecting against price increases, protecting against promotion period, balanced capacity production site and finally increasing the customer service level,

Lyson and Farrington (2006) discussed an inventory system composed of a large number of elements which has to perform function of major significance to the company. Hax (1976) proposed the first place to indentify the type of system needed, based on the elements present in the product structure of the firm and the degree of complexity involved in the market. In order to prescribe an inventory system, they can be identified as follows:

2.1.1 Pure inventory systems are intended to support decisions, regarding the replenishment of inventories for individual items; they are basically used to support only purchasing decisions.

2.1.2 Production-inventory system applies to situations where the firm manufacturers the finished products internally and the manufactured items normally compete for production capacity. Therefore simple order point-order quantity rules, which ignore item interactions, are no longer effective control tools. Higher level decisions have to be made for the allocation of scarce resources among the competing items. The specific methodologies vary significantly with the type of production process involved in the manufacturing activities. Particularly, a fabrication or intermittent process has to be controlled quite differently from an assembly or continuous process. The approach shows that a model inventory system allocates production capacity and labor at the aggregate level.

Effective inventory management is one of the key factors to increase productivity and profitability in organization. However, many of the decision rules presented in inventory management show a basic knowledge of the key elements in inventory studies. The classification of inventory is as follows:

Figure 2.1: Classification of Inventory

Inventory

Inventory type	Inventory Classification	Inventory related cost	Inventory demand type
- Raw meterials	- A Items	Holding cost	- Independent
- Components	- B Items	Ordering / setup cost	- Dependent
- Work-in-progress	- C Items	Unit cost	
- *Subassemblies*		Shortage cost	
- Finished Goods			
- Mainternace, repair and operating materials not embodied in the finished product			

Source: Lysons and Farrington (2006, p297)

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2.2 Assemble-to-Order (ATO)

One of the key performances of a Supply Chain is being fast on delivery lead time. Customers want delivery lead times to be as short as possible. ATO is one of the strategies to provide better delivery lead times. ATO mean that the product is made from standard components that the manufacturer can inventory and assemble, according to a needed and inventory held ready for assembly. Customer involvement in the design of the product is limited to selecting the component part options needed (J.R. Tony Arnold and Stephen N. Chapman, 2004).

Figure 2.2: Manufacturing strategy and lead time
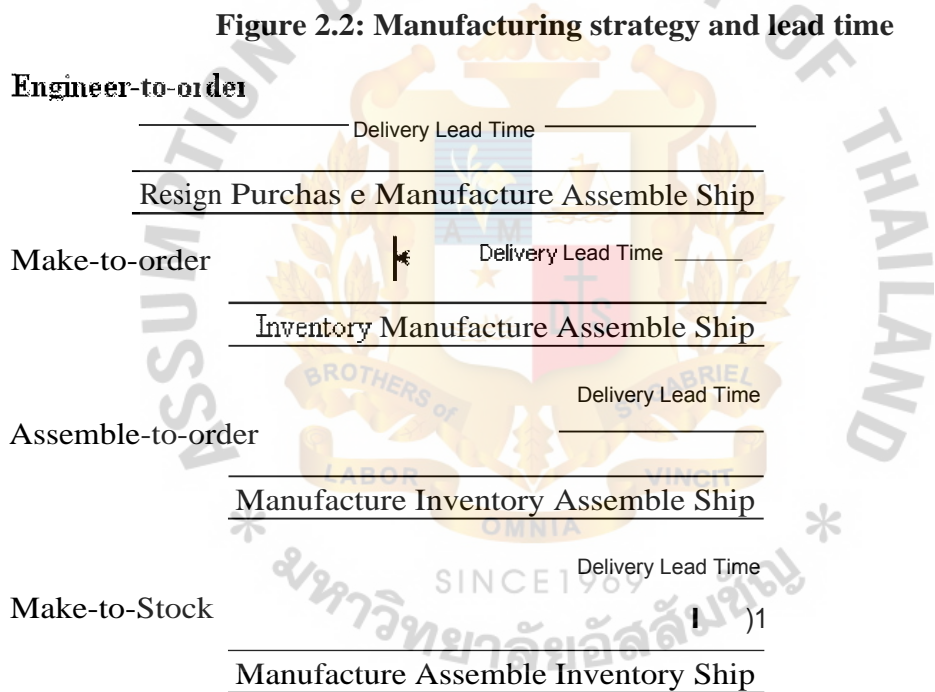
Source: Arnold and Chapman (2004, p4).

The above Figure presents the shortest lead time for delivery as the MTS manufacturing strategy, so the inventory is managed to have all finished goods ready to ship to customers. The next shorter lead time to delivery is the ATO manufacturing strategy, so inventory is held in standard components ready for assembly.

The determination of inventory levels is concerned with inventories involving industrial production, namely inventories of raw materials, purchased and

manufactured parts, subassemblies, assemblies and finished products. However, many of the decision rules are presented for managing inventories, and ATO is another type of decision to manage inventories (Arnoldo and Candea, 1984).

Arnold and Stephen (2004), stated that assemble-to-order (ATO) production has become a strategy for manufacturing firms that seek to be both responsive and cost efficient. ATO production enables a firm to shorten its response time to its customers by staging inventory of components ahead of demand while postponing the final assembly until demand is realized. This strategy is particularly valuable with component inventories. ATO can reduce the costs of offering higher product variety, and it can be useful when demand for individual end-products is variable.

In addition, the manufacturing features of ATO systems are present in several other settings where demand is correlated across several items or ordered for either multiple items from the same customer which must be fulfilled simultaneously.

Song and Zipkin (2003) provided an excellent survey of the literature. The ATO system is an efficient way to deliver a high level of product variety to customers while maintaining reasonable response times and costs. The major US automobile companies are studying ambitious ATO systems for the assembly of cars.

In a study by Berry, Tallon and Boe (1992) they found that the product structure analysis for the Master Scheduling of ATO product can be used to improve the design of the Master Production Scheduling (MPS) system for ATO products because of the reduction in the number of MPS records which are required for scheduling under the condition of wide end-product variety. In addition, the benefits of improved operating performance can be maintained as design changes occur, and can be reprocessed only as required by the component commonality.

ATO calls for effective variety management, and shows the realization of diverse products at low costs and high quality proposed by Du and Yuan (2003). The planned

level of capacity utilization does have a significant effect on the performance of an ATO and the total cost (both out-of-pocket and opportunity).

In terms of the planning process presented by Vollman and Berry (2005), the assembly level with high accuracy is very important so as to reduce obsolescence and reduce the delivery time of the customer's specific product. With demand planning at assemble level, more accuracy of a promised delivery time (service level) and limit of obsolescence can be improved. The ATO environment clearly illustrates the two-way nature of the communication between customer and demand management in this environment. The independent demand for the assembled items is transformed in dependent demand for the parts required to produce the components needed. The inventory that defines customer service is the inventory of components, not the inventory of finished products.

Table 2.1: Key Demand Management Tasks for Each Environment

Task.	MTS	ATO	MTO
Information	Provide forecast	Configuration management	Product specifications
Planning	Project inventory levels	Determine delivery dates	Provide engineering capacity
Control	Assure customer service levels	Meet delivey dates	Adjust capacity to customer needs

Source: Vollmann (2005, p23)

John (2008) studied ATO's production environment where a good or service can be assembled after receiving receipt of a customer's order. The key components (bulk, semi-finished, intermediated, subassembly, fabricated, and so on) used in the assembly or finishing process are planned and usually stocked in anticipation of a customer order. Receipt of an order initiates assembly of the customized product. This strategy is useful where a large number of end products (based on the selection of options and accessories) can be assembled from components.

Blecker, Thorsten, Addelkafi and Nizar (2006) defined an ATO as system consisting of push and pull parts. In the push part, undifferentiated components and subassemblies are manufactured to forecast, whereas in the pull part, end products are

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assembled according to customer specifications. This part is customer driven and largely determines how long customers wait between order placement and delivery of final products. Thus, assemble-to-order longer delivery times than traditional, in which products are directly picked out from the shelf. However, customers generally accept this delay because they highly value customized products which naturally require a specific time for assembly and shipment after order placement. On the other hand, ATO induces high product variety and the consequence that results form product variety is a high demand variability of components. An analysis of component demand variability enables one to identify the components with low or high demand variability. These components can further be classified into supplier and in-house made components.

Tirama (2008) considered an ATO strategy increasingly being coupled with a customer differentiation strategy. Firms segment customers in different classes to which they offer the same product but with different level of service quality. Customers may be differentiated based on the price, the volume they purchase or the products market segment. Firms affect the quality of service received by different customers via inventory allocation decisions.

Magertta (1998) suggested that the ATO model enables a company to reduce uncertainty while minimizing inventory cost in an industry that is characterized by volatility of customer demand and rapid progress of technology.

2.3 Make-to-stock (MTS)

The Make-to-Stock (MTS) strategy focuses on the demand management activities in the maintenance of finished goods inventory. The manufacturer wants to be ready with the stock when a customer demands it in an order. This will lead to reduced lost opportunity of sale. One of the main factors that generate a need to manufacture based on forecast is the reducing lead times acceptable to the customer. Since customers are not willing to wait for their requirements, the manufacturers are driven to anticipate the demand and manufacture based on the forecast.

The forecast of future demand is made based on historical data of customer orders or shipment levels and patterns. However, the actual demand may be very different from the order stream. To be more accurate, the enterprise looks at collaborative demand forecasting. By providing business partner visibility into inventory, and by collaborating on a single shared forecast of customer demand, supply chain partners can positively impact a set of key business drivers to create value across supply chain partners. Some MTS firms employ plant warehouses, distribution centers, local warehouses and even vender-managed inventory inside their customers' locations. This supply chain requires information on the status of inventory in the various locations and estimates of the customers' demands.

The manufacturer tries to preempt the requirements of the customer and then manufacturers the goods based on forecasted; the manufacturer's approach would keep the goods close to the place of sure demand and also reduce the delivery time to customers. In satisfying customers in the MTS environment, it is a balance of the level of inventory against the level of service to the customer.

Bertsimas and Paschalidis (2001) suggested that the MTS environment is a common mode of operation for many industries such as retail products and appliances. Typically, in the MTS manufacturing systems, a positive *Finished Goods Inventory* is maintained which is used to fill arriving orders. The fundamental problem in such systems is to determine how much inventory to maintain so that the carrying inventory cost is balanced against the cost of unfulfilled demand due to stock-out.

2.4 ABC Classification

Supply Chain Management has now evolved beyond a mere cost reducing business function into a core competency and source of competitive advantage for many firms because of its impact on customer service which is the output of the entire logistics functions. In the highly competitive marketplace where products, prices and quality are easily imitated, superior customer service can be the key element that ranks one

firm above another Lambert (1998). Thus, one of the key activities related to costs is inventory management.

Customer satisfaction, the outcome of the logistics function, "Involves getting the right product to the right customer at the right place, in the right condition and the right time, at the lowest total cost possible" (Lambert et al., 1998). ABC is the method by which this critical cost data can be gathered for analysis and utilization either in a single firm or among the firms in the supply chain, and has been studied extensively (Lin, Collins and Su, 2001). ABC is the preferred costing technique since it logically allocates all costs to activities, which can them be meaningfully allocated to cost objects.

The ABC inventory control system is a useful technique for determining which should be priority inventory items, by assigning them to groups A, B and C. A items are given the highest priority, while C items have the lowest priority. The priority is most often determined by annual dollar usage. However, priority may also be determined by shelf life, sale volume, whether the materials are critical components, or other critical factors. When prioritizing inventories by annual dollar usage, the ABC system suggests as follows:

- The A items are approximately 20 percent of the items make up about 80 percent of the total annual dollar usage
- The B items make up approximately 40 percent of the items and account for about 15 percent of the total annual dollar usage
- The C items remaining 40 percent of the items make up about 5 percent of the total annul dollar usage of inventory

Since the A items are the highest annual dollar usage items, these items should then be monitored more frequently and may have higher safety stock levels to guard against stock-outs. C items would then be counted less frequently, and stock-out may be allowed so as to save inventory space and carrying cost. An ABC inventory classification is shown in the example below.

Table 2.2: Example of an ABC inventory classification

Inventory Item Number	Items Cost ($)	Annual Usage (Units)	Annual Volume ($)	Percent of Total Volume	Class
A246	1	22,000	22,000	35.2	A
N376	0.50	40,000	20,000	32.2	A
CO24	4.25	1,468	6,239	10.0	B
R221	12.00	410	4,920	7.8	B
P112	2.25	1,600	3,600	5.8	B
R166	0.12	25,000	3,000	4.8	B
T049	8.50	124	1,054	1.7	B
B615	0.25	3,500	875	1.4	C
L227	1.25	440	550	0.9	C
T519	26.00	10	260	0.4	C

Source: Wisner, (2005, p176)

Note that the A items only account for about 67 percent of the total annual dollar Volume, while the B items account for about 28 percent. This illustrates that judgment may be allowed to save inventory space and carrying cost. An ABC inventory must also be applied when using the ABC method and the 80/20 rule should only be used as a general apportionment.

2.5 Slow-moving inventory

According to Richard (2009), most buyers and planners do not effectively manage slow moving inventory because it is not a significant part of revenue. However, it is a significant part of the inventory investment and requires a strategic approach to improve the overall inventory performance. If a company wants to reduce inventory, improve inventory turns, and achieve service level targets, there must be a strategic

focus on how stocking strategies are generated, especially for generating stocking strategies for slow moving inventory. One proven approach is through the deployment of inventory optimization techniques that align the inventory investment with these business objectives.

2.6 Inventory Turn

Inventory is always evaluated by turnover, a measure of the velocity which material moves through the organization. Two measures are related to sales inventory turns ratio and days of supply. Turnover is the ratio of the annual cost of good sold to the average or current inventory investment.

$$\text{Stock turn over} = \frac{\text{annual cost of good sold}}{\text{Average inventory in dollars}}$$

At the least, the result means that inventory is able to generate less profit. If through better material management, the firm is able to increase its turn ratio, so in inventory results there is cost reduction and profit increase (Arnold and Stephen 2004).

Lower investment on the other hand in stock measurement as days of supply, can express the ratio as a number of days.

$$\text{Days of supply} = \frac{\text{inventory on hand}}{\text{Average daily usage (cost of goods sold/365)}}$$

The result of this ratio gives a number of days on average which the stocks are held in the business. If the ratio decreased that is probably a good thing, meaning the cost of carrying inventory reduces to generate faster profit increase.

2.7 Cross-Functional teams

Many activities are identified in Supply Chain Management key drivers by the cross-functional team. It become a common approach to addressing many supply management related activities, operating equipment, the acquisition of capital and problem solving and development of strategic alliances. Since cross function teams require a significant investment in human resources, their use is commonly limited to time-critical and high monetary value activities. All benefit from a variety of functional inputs. For example, marketing willingness to deliver products as fast as possible to customers and then get good customer satisfaction. So, in manufacturing processes and their limitations, inventory should have more and more inventory for fast delivery, but with limited space. When these professional come together under the leadership of a capable team leader, the result is normally a synergy.

David (2004) referred to the cross-function approach that greatly increases the likelihood that all issues that should be considered are addressed. Standardization efforts, which are conducted or controlled by functional areas, are helped to reduce organizational resistance to decisions that will affect a specific functional area. The team is more efficient and effective at soling problems than the traditional function. In term of negotiations, they are well-prepared and well-coordinated.

2.8 Summary

The literature reviewed in this chapter concerns the inventory performance and managing inventory concept; trust in the common techniques is widely expressed as minimizing inventory cost and meeting customer satisfaction, were first discussed followed by a review of the MTS and ATO concepts which are two key decisions made on inventory management in the study. Moreover, to reduce the number of items in inventory management, finally the minimize obsolescence inventory will be created, and increase profitability in the organization, as proposed in the next chapter.

CHAPTER III

METHODOLOGY

In this chapter the researcher describes the methodological approach to assess the suitability of the Assemble-to-order (ATO) inventory strategy. Firstly the researcher examines how the trend of obsolescence inventory is viewed, inventory turnover, cost of inventory, safety stock policy and inventory classification. The tool for simulation in this study is Microsoft Excel to determine the safety stock, inventory cost, and inventory turnover for the Hard Coated product and Hard Multicoated product. After that is a comparison between the current and new performance measurement of total inventory cost, stock turnover and service level to the key performance index. In the company's optimal inventory level, by selecting the suitable models in terms of optimization of obsolescence inventory cost and maintaining service level, follows company policy. We further describe an analytical optimization model that supports availability management and determines which profitable product that minimizes the inventory.

Ettl (2006) suggested that the model provides dynamic, real-time sale recommendation based on the current availability performance and customer demand information. The optimization is most effective in an ATO environment where end products are configured from pluggable sales building blocks.

In the following, the researcher will deal with the aspects of the five steps shown in Figure 3.1 which includes the data correction, analyses of the existing inventory strategy and the existing operation process; identifying which are appropriate to propose an ATO inventory strategy, simulation and comparison between a new strategy and the current strategy, and conclusions and recommendations.

Figure 3.1 Research Plan and Steps

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                    ┌─────────┐
                    │  Start  │
                    └─────────┘

        ┌─────────────────────────────────────┐
        │      Step 1: Data Collection        │
        └─────────────────────────────────────┘

        ┌─────────────────────────────────────┐
        │  Step 2: Analyses of existing       │
        │  inventory strategy and existing    │
        │  operation process                  │
        └─────────────────────────────────────┘

        ┌─────────────────────────────────────┐
        │  Step 3: Identify where appropriate │
        │  to propose Assemble to order       │
        │  inventory strategy                 │
        └─────────────────────────────────────┘

        ┌─────────────────────────────────────┐
        │  Step 4: Simulation and comparison  │
        │  between new strategy and current   │
        │  strategy                           │
        └─────────────────────────────────────┘

        ┌─────────────────────────────────────┐
        │  Step 5: Conclusions and            │
        │  Recommendations                    │
        └─────────────────────────────────────┘
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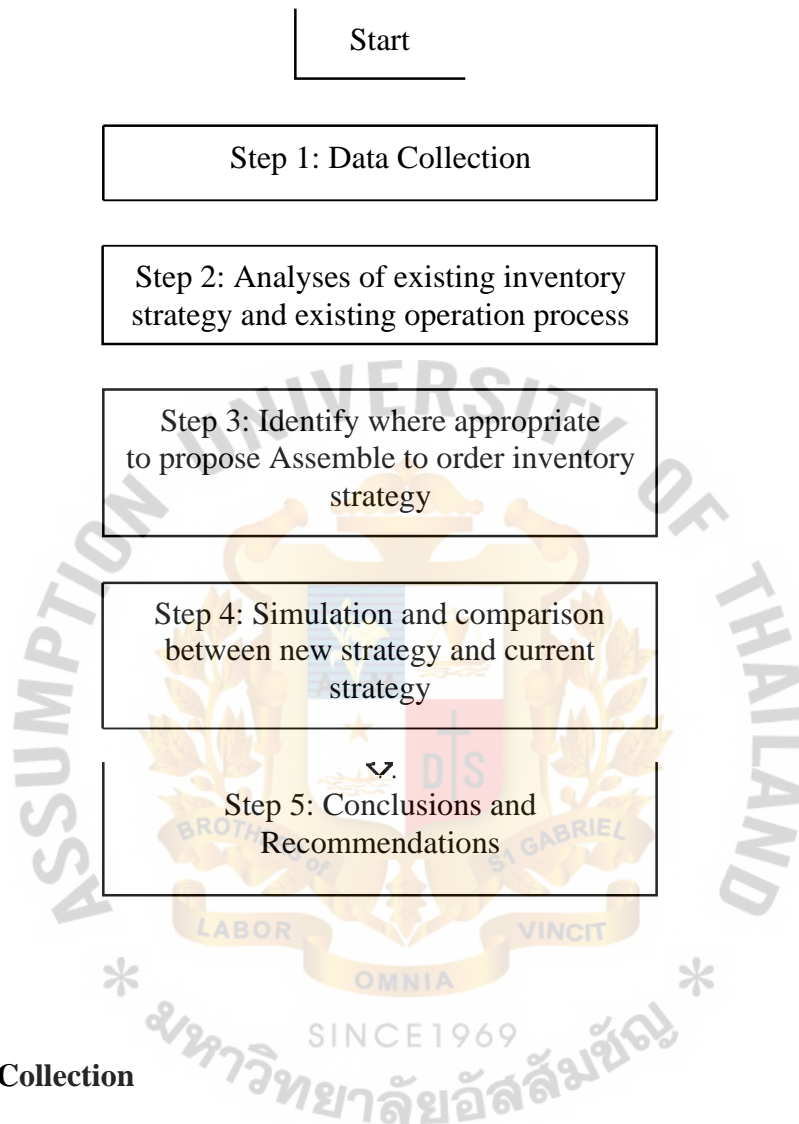
3.1 Data Collection

The researcher collected the historical data from January 2009 to December 2009 from the Finance Department and Supply Chain Department and interviewed the Supply Chain Manager, Finance Manager, Logistics Manager, Warehouse Manager and Production Manager to collect the data and analysis of inventory management. The required detailed data is shown below:

- Ending inventory in each period from monthly financial reports is the portion inventory value and inventory turn in each month

- Actual sale volume of products in each period from monthly sale reports

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- Safety stock data for all items and quantity extracted from the Oracle **ERP** system.
- Classify inventory items by the ABC classification technique
- Cost obsolescence inventory for each product
- Operation process

3.2 Analyses of existing inventory strategy and existing operation process

After all data have been collected the first step is to analysis the inventory turn ratio, and inventory cost, comparing hard coated with hard multicoated products. Next is a safety stock policy to define the safety stock level by classifications of the data (shown in Appendix **II)**. The historical obsolescence items are explored to find out the core of obsolescence considering the different classes of inventory in inventory management by the company's safety stock policy. The existing operation processes are considered where a common component from production is built into inventory.

3.2.1 Inventory turn ratio and inventory cost

The researcher analyzed the existing inventory strategy by inventory turn and inventory cost of product Hard Coat (HC) and Hard Multicoated (**HMC**) presented in Table 3.1

Table 3.1: Inventory turn ratio and inventory cost

Type	Jan'09	Feb'09	Mar'09	Mar'09	May09	Jun09	Jul'09	Aug'09	Sep'09	Oct'09	Nov'09	Dec'09	Total
HC Sale ($)	673,699	618,656	537,303	609124	656045	567849	799,678	921195	941955	1562281	784,165	889,212	9,061,052
HMC Sale ($)	1,738,327	1,896,990	2314357	1,889,940	1905946	1,452533	1382301	951,691	1,466528	1705711	1541,194	1206564	18,932,292
HC Cost of sale ($)	972	892	775	879	946	819	1,154	1329	1359	1532	1,131	1,233	13,072
HC Inventory C ($)	1456	1,408	1,420	1502	1594	1561	1734	1,602	1514	1452	1,647	1,667	18557
HMC Cost e ($)	1508	1,646	2,008	1,639	1,653	1,260	1,182	826	1,272	1,480	903	1,047	16,423
C Inventory Cost ($)	2,286	2362	2325	2291	2281	2,385	2332	2,045	2,115	1797	1,840	1,887	25,947
HC Inventory Turn (Days)	20.03	1951	1637	1755	17.82	15.74	19.96	24.89	26.92	31.66	2561	2359	21
HMC Inventory Turn (Days)	28.96	25.67	21.23	27.49	28.91	37.17	44.01	58.20	35.70	29.44	54.69	47.77	

Source: Optical Company Finance Department

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Those showed sales in year 2009 for the HMC product as 18 9 million dollars while HC product is 9 million dollars, when focusing on the inventory performance the inventory cost product HMC reached 25,947 dollars, but product HC approximately 16,432 dollars. On the other hand, the inventory turnover ratio of product HMC showed 21 days whereas product HC showed 19 days, meaning that the cost of carrying inventory is generated, thus effecting a decreased benefit (Arnold and Stephen 2004).

3.2.2 Safety stock policy

The Optical Company had an inventory target policy and inventory management strategy by MTS, and had a safety stock level policy which served a vital role in buffering against supply and demand uncertainty. The inventory target policy was:

a) Product Make to stock all class items to defined safety stock level

b) Safety stock level differenced according to the ABC classification

c) ABC classification Class A items are defined by accumulative sale value of 60%, Class B as 80% and Class C as 100% (see Table 3.2).

d) Review safety stock quarterly

Table 3.2: Inventory Policy

Class	% Accumulate Sale	Safety Stock coverage of average month sale
A	60%	1.00
B	20%	2.00
C	20%	2.50
	100%	

Note: Average month sales formula used average of the next 6 months forecasts

Source: Optical Company Supply Chain Department

Table 3.2 shows how to classify ABC classes by percentage of cumulative sale value, grouped by descending annual value of sale on each item, calculated the percentage of the total annual sale for each inventory items, determine the cumulative percentage annual sale and then assign items to each Class, such as class A accumulated 60% of

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annual value of sale, Class B accumulated from 60.01 % - 80% of annual value of sale and Class C 80.01% to 100 %.

In order to more understand the Safety stock company policy, the researcher would like to present the process to define safety stock level by classifications. The data shown in Appendix I cover the following step of calculation

    1) ABC Classification

    2) Safety stock within the ABC class and target monthly coverage.

Regarding the inventory target policy, all items are kept in the Make to Stock strategy. The resulting ABC analysis shows in Table 3.2 that class A had 66 items consisting of 13.55 % of all items which generate revenue at 21 7 million dollars as 60 % of the total revenue, while class B generate revenue at 7.24 million dollars, as 20% from the total revenue consisting of 68 items, and class C consisted of 353 items but generated revenue 7.28 million dollars as 20% of the total revenue also. However inventory management of more than 70% is for items in class C.

Table 3.3: ABC Classification of data January to December 2009

Class	Annual Sale value ($)	% of Annual Sale	Number of Items code	% Number of Items code
A	21,720,921	60%	66	13.55%
B	7,244,079	20%	68	13.96%
C	7,289,486	20%	353	72.48%
Grand Total	36,254,487	100%	487	100%

Source: Optical Company Supply Chain Department

Next is the calculation of safety stock within the ABC classes and target coverage of monthly sales. For example, Class A items are fixed on 1 month coverage of sales and all data is shown in Appendix **II**. The researcher would like to show the example that items X-0100-00000 had monthly sales of about 62,045 pieces, so the safety stock is defined as 62,045 pieces and maintaining inventory at this level (show n in Table 3.4). The example of safety stock calculation follows:

Table 3.4: Example: safety stock for class A

Items code	Annual Sale value ($)	Quantity on Monthly sale	% of Annual Sale	% of Accumulate annual Sale	Class	Safety stock	Target coverage sale	Obsolesence
X-0100-00000	863,666	62,045	2.38%	2.38%	A	62,045	1	1210
X-0200-00000	802,224	57,631	2.21%	4.59%	A	57,631	1	1843
X-0125-00000	775,024	55,677	2.14%	6.73%	A	55,677		1640
X-0075-00000	766,045	55,032	2.11%	8.85%	A	55,032	1	1184

Source: Optical Company Supply Chain Department

Class B is fixed on 2 month sales of example items X-0225-02500, with estimated monthly sales of about 11,265 pieces, so the safety stock is defined as 22,530 pieces and fulfills the inventory at this level.

[Table 3.5: Example: safety stock for class B

Items code	Annual Sale value ($)	Quantity on Monthly sale	% of Annual Sale	% of Accumulate annual Sale	Class	Safety stock	Target coverage sale	Obsolesence
X-0225-02500	156,809	11,265	0.43%	60.34%	B	22,5:3U		2967
X+0075-02500	155,709	11,186	0.43%	60.77%	B	22,372		4467
X-0475-00000	155,208	11,150	0.43%	61.20%	B	22,300		1789
X+0025-07500	153,802	11,049	0.42%	61.63%	B	22,098		3730

Source: Optical Company Supply Chain Department

Class C is fixed on 2.5 monthly sales of example items X-0575-00000, with estimated monthly sales of about 5,166 pieces, so the safety stock is defined as 12,915 pieces and fulfills the inventory for all items.

Table 3.6: Example: safety stock for class C

Items code	Annual Sale value ($)	Quantity on Monthly sale	% of Annual Sale	% of Accumulate annual Sale	Class	Safety stock	Target coverage sale	Obsolesence
X-0575-00000	71,911	5,166	0.20%	80.09%	C	12,915	2.5	1373
X+0150-02500	70,950	5,097	0.20%	80.29%	C	12,743	2.5	3974
X-0275-10000	69,976	5,027	0.19%	80.48%	C	12,568	2.5	4319
X-0125-12500	69,823	5,016	0.19%	80.67%	C	12,540	2.5	2034

Source: Optical Company Supply Chain Department

The safety stock is shown in Appendix **II,** using the formula below:

Annual sale value	= (Quantity on Monthly sale * 12 month)*Unit price
	(Sort by descending)
Quantity on Monthly sale	= Average of the next 6 months forecasts
	(Sort by descending)
Percent of Annual Sale	= Annual sale value per item / Summary annual sale
Class	= Determine the cumulative percentage annual sale and
	then assign items to the class based on the inventory
	value criteria
Safety Stock	= Target coverage sale*Quantity monthly
Target coverage sale	= Based on the policy of each class

3.2.3 The historical obsolescence data

After safety stock were assigned and then the full inventory, next the researcher analyses the obsolescence by year. The data collected trend of obsolescence is shown in Figure 3.2 with the historical aspect of the last 3 years.

Figure 3.2: Historical Obsolescence
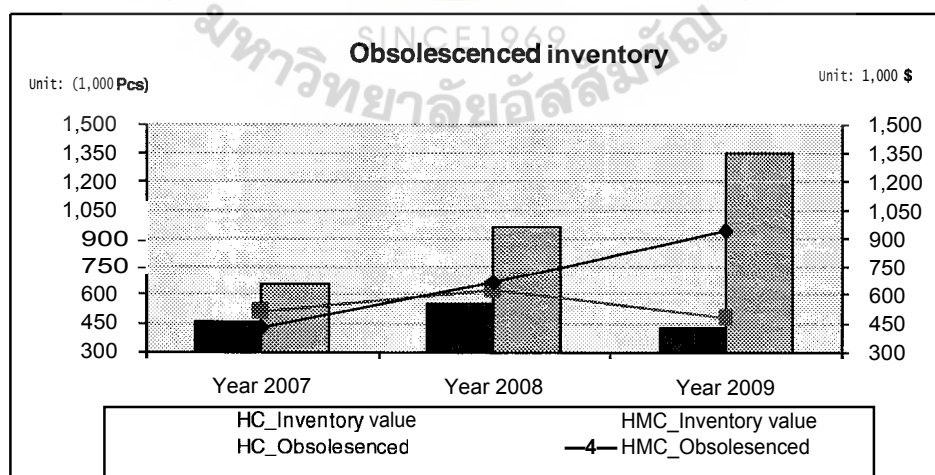
Source: NA Company Supply Chain Department

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Product HC obsolescence increased from the year 2007 to the year 2008 from 453,000 dollars to 548,000 dollars. In year 2009 obsolescence decreased to 418,000 dollars, while HMC products' trend of obsolescence inventory increased in the year 2009 to 1,348,000 dollars. Approximately 70-80 % of the cost of obsolete is related to the HMC product.

As mentioned in the inventory policy, the period to review of safety stock quarterly, some items in the past had high forecast sale and inventory already filled up to the safety stock; when the forecast decreased that means that obsolesced inventory increased. When focusing on the detail of items increasing the obsolescence, the majority of the Class C products to increase the risk of inventory cost through obsolescence. Referring to Table 3.7, Class A and B items have no obsolesced inventory, and HMC product Class C generated an obsolesced cost of 1 3 million dollars, around three times the HC product, and the inventory cost of the HMC product higher than the HC product. Nevertheless the inventory turns of the HMC product are better than the HC product.

Table 3.7: Inventory management analysis

| Product | Inventory Turn Unit: Day | Inventory Value Unit $ | Cast of Obsolescenced | | |
			Class A Unit: $	Class B Unit, $	Class C Unit S
HC	.22	1,603,951	0.	0	417,504
HMC	34	2,908,095	0	0	1,348,444

Source: Optical Company Financial and Supply Chain Department

However, the growth of complexity rapidly proved unmanageable, creating a large obsolesce inventory, especially for class C items were very irregular. Therefore, with difficulty in forecasting consumption, most of these products cannot be incompatible with market needs.

3.2.4 The existing operation process

The significant operations processes in this case study are indicated in Figure 3.3 (in the As-Is box shown), for the current process in which items are defined as Make to stock. All classes A, B and C, need a production built inventory. At this stage, the production process starts from injection, passes to Hard coat process, passes to Hard multicoated process and packing and then to inventory keeping, so the production process flow is common to the Hard coat process.

Figure 3.3: The existing operation process
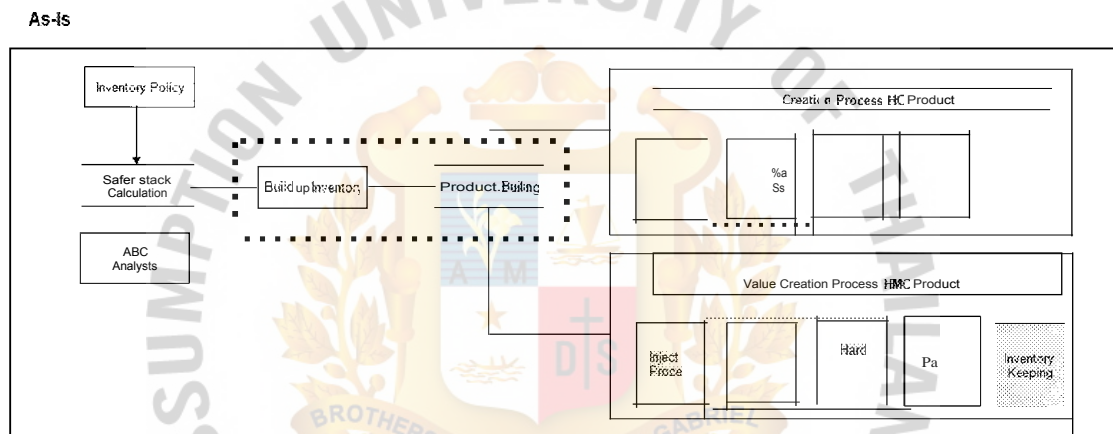
Source: Optical Company production department

Andersion (1997) suggested the variety of processes distinguishes between two types of variety that can be external or internal. External is the variety that is seen by customers, where internal variety is experienced inside the manufacturing.

In the highlighted box, as the opportunity to trade off between diversity and costs should be made, the beginning process is the inventory policy and then the definition of safety stock by ABC classification. In this step is room to trade off between diversity and cost, and after that to find the common process in hard coat.

Lee (1998) presented the redesign of the product structure in such a way that some early steps of the process are standardized.

3.3 Identify where appropriate to propose Assemble-to Order inventory strategy

According to all the data collection and analysis, the HMC product has the opportunity to develop inventory management and improve inventory performance. The researcher found the majority of inventory costs, such as trend of cost obsolesces increased especially in the Class C items (referenced in Table 3.6), although the inventory turn ratio on the HMC product is better than for the HC product. High value ratio indicates better firm performance (Water 1992). Also to find the next element concerning the operation process, found that the HMC product had one distinguishing feature between make-to-stock and assemble-to-order, as depicted by Figure 3.2. The common processes are the injection process and hard coat process (from discussions between the Supply Chain manager and Production manager).

Gunasekaran and Ngai (2005) pointed out that in build-to-order, the components and parts are ready for assembly. They defined the build-to-order as "the value chain that manufactures quality products or services based on the requirements of an individual customer or a group of customers at competitive prices".

The coordination afforded by Assemble to order provides significant improvement of the inventory performance and avoids obsolescence when new product innovation changes. The Assemble-to-order model enables uncertainty while minimizing inventory costs in an industry which is characterized by the volatility of customer demand and rapid progress of technology (Magretta 1998).

Literally, there are several deterministic on assemble-to-order models with different circumstances, but the common techniques widely express minimizing inventory costs as summarized in Table 3.8.

Table 3.8: Literally deterministic in Assemble-to-Order models

Author	Article Related	Methodology	Topic discussions	Finding
John H et al.(2008)	A large number of end products	Text book	Introduces the Assemble-to-Order inventory strategy was useful where a large number of end products can be assembled from components	Reduces the number of items in the inventory management
Journal " Strategic direction" (2008)	Products more innovative and deliver new products more efficiently	Journal	Mentions companies to have more innovative products, gained by cutting product cost in the manufacture and assembly	The firms can meet innovation, quality, time to market and avoid new product innovation change
Magretta & Joan (1998)	Optimized inventory of components and operated its assembly system	Research interview: Dell's computer's Michael Dell	To assembly with nearly finished goods, no work in process inventory	To reduce uncertainty while minimize inventory cost
J.R. Tony Armold and Stephen N. Chapman (2004)	Inventory measurement	Text book	Inventory evaluated by Stock turn over and Days of supply	Inventory performance, inventory results in cost reduction and profit increase
Richard et al.(2009)	Effectively manage slow moving inventory	Journal	How stocking strategies are generated for slow moving inventory	To reduce inventory, improve inventory turn, and achieve service level targets
David (2004)	All issue considered are addressed	Text book, case study	Approach greatly increases likelihood, all issues should be considered is addressed	To have standardization efforts for more efficient and effective solving problems

In this case, studying the operations process is indicated in Figure 3.3 on the As-Is box shows the current process flow starting from which items are defined as Make to stock. All class A, B and C need production built inventory. At this stage, production process starting from injection, pass to Hard coat process, pass to Hard multicoated process and packing and then inventory keeping, so the production process flow on the sub assembly as the Hard coat process, meaning all the product Hard multicoated pass through Hard coated process as the commonality that have opportunity in the inventory management level, to reduce variety of items inventory and obsolescence.

Blecker and Thorsten (2006) suggested the necessary components are picked out from stock and combined in the main assembly line into customized products which are shipped to customers.

Figure 3.4: Operation process
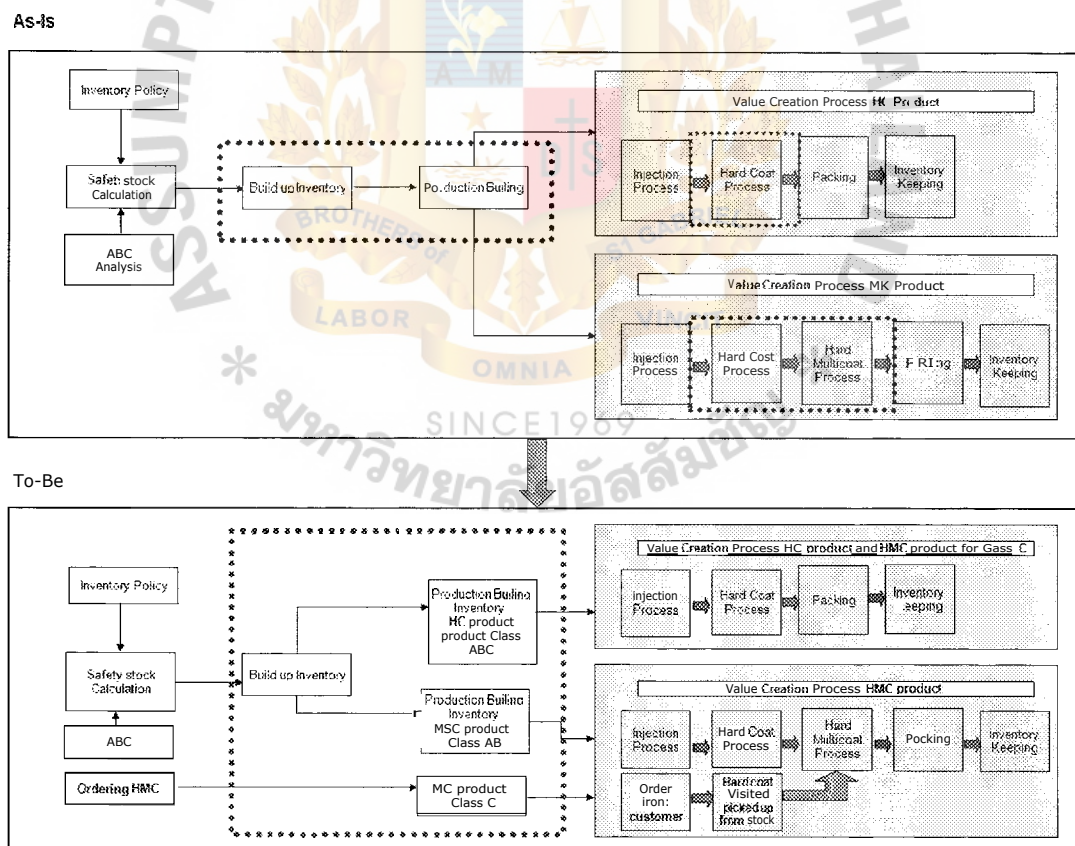
Source: Optical Company production department

As the To-Be box to customize HMC product in the Class A and B items in the current operation process flow to build up inventory on finished goods; for Class C items build up inventory by common process and then pick up components from stock to Hard multicoated process when the customer orders, will improve inventory management, by shown in Table 3.9:

Table 3.9: Inventory management As-Is and To-Be

Description	As-Is		To-Be	
	HC product	HMC product	HC product	HMC product
Inventory Turn (unit: days)	21	19		
Inventory Value (unit: 5)	1,603,951	2,908,095		
Cost of obsolesced Class A (unit: $)	0	0		
Cost of obsolesced Class B (unit: ft	0	0		
Cost of obsolesced Class C (unit · $)	936,420	1,348,444		
Day of supply ::unit: days)	89	78.		
Number of items inventory management	4,932	12,444		

Therefore, the researcher focuses on the HMC product. Thus, it indicate that all data of historical obsolescence, inventory turn, inventory cost and operation process in HMC product are good and suitable for the next step to propose a new strategy. Next, the researcher will present simulation and comparison between the new strategy and the current strategy.

3.4 Simulation and comparison between new strategy and current strategy

According to the data collection in Step 1, the researcher focuses on those items that have a high impact on obsolescence inventory cost increase, and an impact on the benefits to the company. The researcher will focus on 80% of obsolesced items in a pilot study as shown in Table 3.10.

Table 3.10: HMC Product's obsolesced

Items code	Quantity on Annual sale ($)	% of Annual Sale	% of Accumulate annual Sale	Class	Ending inventory on Dec'09 (Piece)	Obsolesced Cost ($)
	5,777	0.02%	99.61%	C	5,462	12,555
X-0475-02500	42,651	0.12%	88.62%	C	9,416	12,135
X-0525-02500	26,796	0.07%	94.01%	C	8,659	12,105
X-0475-17500	9,758	0.03%	98.78%	C	6,570	11,732
X-0525-15000	7,600	0.02%	99.25%	C	7,098	11,679
X-0500-02500	32,684	0.09%	91.40%	C	9,520	11,611
xxx	xxx	xxx	xxx	C	xxx	xxx
xxx	xxx	xxx	xxx	C	xxx	xxx
xxx	xxx	xxx	xxx	C	xxx	xxx
xxx	xxx	xxx	xxx	C	xxx	xxx
X+0550-07500	459	0.02%	98.86%	C	925	10,258
X+0475-02500	390	0.02%	99.02%	C	1,436	8,246
X+0575-17500	251	0.08%	100.00%	C	844	8,100
Total obsolesced						1

Source: Optical Company financial and supply chain department

Currently, all the Class C items in HMC are3 managed by the MTS strategy, so the example of the 80% of obsolesced inventory cost is 1,078,754 dollars 9 (all items are shown in Appendix E). Next, is to find the day supply expressed in Table 3.11.

Table 3.11: As-Is HMC Obsolesced Inventory Performances

Items code	Quantity on Monthly sale (Piece)	Ending inventory on Dec'09 iece	% of Annual Sale	% of Accumulate a nual	Class	Obsolesced Cost (31	ae ge dai ale s t	s ply (da s)
	A					C=A		D=B÷C
X-0525-17500	415	5 462	0 0 %	99 61%	C		14	395
X-0475-02500	3,064	9,416	0.12%	88 62%	C		102	9
X-0525-02500	925	8,659	0.07%	94.01%	C	,105	64	135
X-0475-17500	70	70	0.03%	98 78%	C		23	281
X-0525-15000	546	7,098	0 02%	99.25%	C	11.679	18	390
X-0500-02500	2,348	9,520	0 09%	91.40%	C	11,611		122
xxx	xxx	xxx	xxx	XIS	C	xxx	xxx	xxx
xxx	xxx	xxx	xxx	xxx	C	xxx		'S lx
XXX	XXX	7	XXX	xxx	C	XXX	xxx	xxx
XXX	xxx	xxx	XXX	xxx	C	xxx	xxx	XXX
X+0 50-07500	33	925	0.02P-5	98 86%	C	10058	1	925
X+0475-02500	28	1,436	0 02%	99 02%	C	8,246	1	1,436
X+057 7500	18	844	0 08%	100.00%	C	8 100	1	844
I	523.67	1,946,599					754	

Source: Optical Company financial and supply chain department

The above data shows the quantity of monthly sale as 523,670 pieces, and the end of the year 2009 had inventory of 1,946,599 pieces and had an obsolescence inventory cost of 1,078,754 dollars. In the example of item x+0550-07500, the days of supply approximate 1,436 days or around 4 years, meaning that obsolescence will be created the next coming year.

To propose Assemble-to-Order, would be to increase safety stock in the main component items of the hard coat product. The first step is to calculate the safety stock level based on the company's policy (as mentioned in 3.2.1) as the existing inventory strategy.

Then it includes the dependence demand (HMC demand to HC); Table 3.12 presented the transfer demand of HMC class C to HC.

Table 3.12: To-Be Combine Demand to HC

Items code	Ending inventory on Dec'09 (Piece)	A Monthly Sale_HMC (Piece)	B Monthly Sale_HC (Piece)	A+B Total Demand (Piece)	2.5*(A+B) Safety stock (Piece)
X-0525-17500	5,462	415	>12	727	1,818
X-0475-02500	9,416	3,064	2,298	5,362	13,405
X-05 5-02500	8,659	1,925	1,444	3,369	8423
X-0475-17500	6570	701	526	1,227	3,068
X-052 —15000	7098	546	410	956	2,390
X-0500-025 .	.,52	2,348	1,761	4,109	10,273
XXX	X52.:	XXX	XXX	XXX	XXX
XXX	XXX	XXX	XXX	XXX	XXX
XXX	XXX	XXX	XXX	XXX	XXX
XXX	XXX	XXX	XXX	XXX	XXX
X-0400-17500	925		5	58	145
X-0550-15000	1,436	28		49	173
X-0100-17500	844	18	14	32	SO
	1,946,599				

Source: Optical Company financial and supply chain department

The items x-0525017500 had the requirement of HMC product and HC product. Therefore when defining the safety stock will include the demand of both products and then calculate the safety stock following the policy method.

Table 3.13: To-Be HMC inventory performances

Items code	Obsolesced As-Is ($)	Obsolesced To-Be ($)	Days of supply As-Is (days)	Days of supply To-Be (days
X-0575-7500	12,555	9,599	395	225
X-0475-2500	12,135	778	92	5
X-052-02500	12,105	44,473	135	77
X-0575-17500	11,732	16,199	281	161
X-0525-5000	11,679	12,619	390	225
X-0500-02500	11,611	54,1	127	70
XXX	XXX	XXX	XXX	XXX
XXX	XXX	XXX	XXX	XXX
XXX	XXX	XXX	XXX	XXX
XXX	XXX	XXX	XXX	XXX
X+0550-07500	10,258	766	925	478
X+0475-02500	8,246	649	1,436	879
X+0575-17500	8,100	422	844	791
	1,078754	755,128		

Source: Optical Company financial and supply chain department

The last step is the comparison of the results from the current inventory performance with the best solution of the proposed model ATO for the HMC product specifically in Class C to see if the selected model meets the inventory cost, days of supply and the service level. Inventory cost is measured by comparing the As-Is total inventory cost to find out inventory cost decreasing from 1,078,754 dollars to 755,128 dollars. Days of supply will compare the As-Is model with the To-Be ATO model, item by item. We found that the performance has improved. As an example, for items x-0525-17500 the days supply from 395 days to 225 days. Days of supply is obtained from:

$$\text{Days of Supply} = \frac{\text{Inventory on hand}}{\text{Average daily sale}}$$

3.5 Conclusions and Recommendations

In this chapter, the researcher had simulation and analysis of inventory measurement using for research purposes the data corrected and measured, and interpreted the results comparing the results of As-Is with To-Be by proposal a new model, the Make to Assemble model with the inventory of HMC product in Class C. For a better understanding, the inventory performance comparison between MTS and ATO is presented in the next chapter.

CHAPTER IV

PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

In this chapter, the researcher presents simulation and comparisons between the new strategy and the current strategy, after the application of assemble-to-order, described in chapter III, in order to prevent obsolescence inventory. Then the presentation and critical discussion of the results follow, as in the structure below:

Figure 4.1: The presentation and critical discussion of results structure
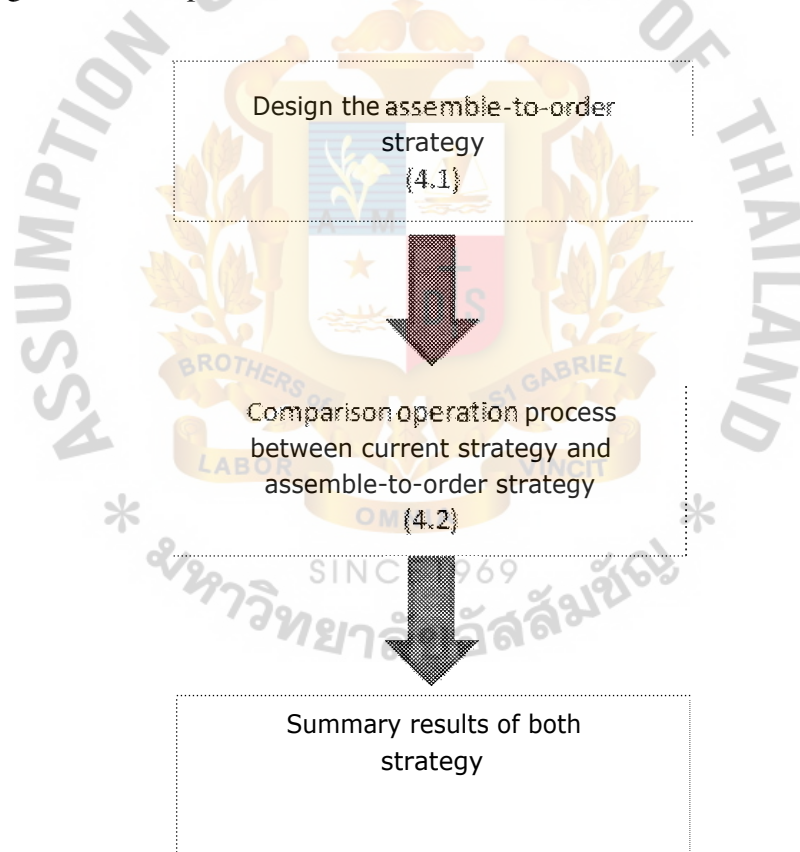
4.1 Design the assemble-to-order strategy

Assemble-to-order can be seen as a form of mass customization with the grouping components, either similar design features or manufacturing process, into part families. The main objective is to reduce the total number of items in the managed inventory. This research focuses on Class C, the hard multicoated product.

4.1.1 Component product's structure

The component product's structure identifies sources of demand. The demand of variety or the product patterns that drive demand variety to create the different point was a real component point and a major point in the operation process; they can be seen to group component demand for assemble-to-order inventory in Figure 4.2. The ending process 2 and ending process 5 were developed to assemble-to-order inventory management. Then the demand for end products was grouped by the common component. After the customer orders arrive and are picked out from stock and combined in the main assembly line into customized products which are shipped to customers. The next step designed safety stock for the component items.

Figure 4.2: The Assemble-to-order develop point

Semi-final product

Assemble-sub-process wich variety increase

Assemble-sub-process wich variety does not increase

ATO develop point
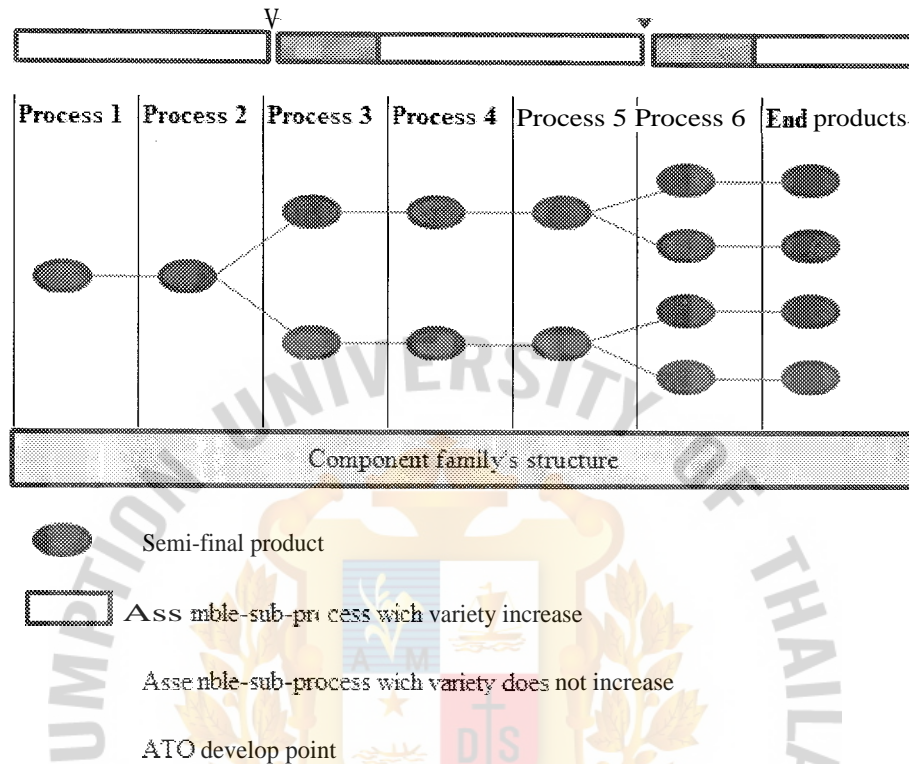
4.1.2 Designed safety stock for the component items

In the ATO model, there were the buffer stocks of the common component items, so the safety stock was moved to the common component items by the safety stock policy as mentioned in Chapter 3. The researcher used the same data in Chapter 3 to calculate the safety stock of common component items as shown in Table 4.1. For items X-0525-17500 the safety stock was calculated from demand both of hard coat product and hard multicoated product to group the demand and design the safety stock.

Table 4.1: The Safety stock of component items

Component items code	A. Monthly sale HMC (Piece)	B. Monthly Sale_HC (Piece)	C= A+B Total Demand (Piece)	D= 2.5*C Safety stock (Piece)
X-0525-17500	415	312	727	
X-0475-02500	3,064	2298	5,362	13,405
-052 -02500	1,925	1444	3,369	8,423
X-0475-17500	701	526	1,227	3,068
X-0525-15000	546	410	956	2,390
X-0500-02500	2,348	1761	4,109	10,273
X-0550-02500	1,723	1293	3,016	
xxx	xxx	xxx	xxx	xxx
xxx	xxx	xxx	xxx	xxx
xxx	xxx	xxx	rim	xxx
X+0550-0 502	33	25	55	145
	25	21	49	123
X+0575-17500	IS	14	32	80
Total	523	0 32a53	9.16553	291.461

4.1.3 Simulation of obsolescence costs

After having calculated, the safety stock which uses total demand to compare with the ending stock in December 2009 to find the obsolescence inventory cost presented in Table 4.2, the To-Be strategy obsolesced inventory total was 755, 128 dollars, and the As-Is strategy was 1,348,444 dollars. The result reduces by 593,316 dollars.

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Table 4.2: To-Be Obsolesced inventory

| | | B | C= A+B | D | 2.5*C |

Component items code	Ending inventory on Dec'09 (Piece)	Monthly sale HMC (Piece)	Monthly Sale_HC (Piece)	Total Demand (Piece)	Safety stock (Piece)	Cost Obsolesced_To-Be)
X-055-17500	5 6	415	.312	727	1,818	8,789
X-0475-02500	9,416	2	2298	5,5	13,405	8,495
-0525-02500	8,679	1,925	1444	3 69	3	
0475-17500	6,570	701	536	1 227	3,068	8,213
0525-15000	7,098	546	4.10	956	2,390	8,176
X-0700-02500	9,520	2,348	1761	4,109	10,2 3	8,128
X-0550-02500	3 6	1,723	1293	3,01	7 540	6
xxx	xxx	xxx	xxx	xxx	NM	xxx
xxx	xxx	xxx	xxx	xxx	xxx	xxx
xxx	xxx	xxx	xxx	xxx	xxx	xxx
			7	58	145	479
X+0475-0 500	1,436	28	21.	49		880
575-17500	844	18	14	52	80	52
Total (Piece)	1,946,599	52,3670	392,8	916,553	291,464	
Total (S)						28

4.1.4 Simulation of days of supply

The results of days of supply in the To-Be model used the total demand, including the common component to calculate the day of supply obtained from:

$$\text{Days of Supply} = \frac{\text{Inventory on hand}}{\text{Average daily sale}}$$

Table 4.3 presented the inventory on hand at the end of December 2009 as 1,946,599 pieces, and the average daily sale is the monthly sale of 916,553 pieces divided by 30 days with the results being 64 days.

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Table 4.3: To-Be days of supply

Component items code	Ending inventory on Dec'09 (Piece)	Monthly sale MK (Piece)	Monthly Sale_HC (Piece)	Total Demand (Pie)	Safety stock (Piece)	a\ s of supply_To-Be a\a\
	A			C= A+B	D= 2_5 *C	
X-0525- 7 00	5 62	415	312		1,818	
X-047 -0 00	9416	3,064		5, 52		5
X-052 -02500	8.6 9	1,925	1444		8,4	78
X-0475- 75 0	6 57	701	526	1 227	3,068	151
X-0525-15800	7,098	546	410	956	2,390	
		2,348	1761	4,109	10,273	7
XXX	XXX	XXX	XXX	a.	X X	XXX
XXX	XXX	:Oa	XXX	KU	XXX	XXX
XXX	XXX	XXX	XXX	XX%	XXX	XXX
X+0 50-07500	425	33	25	59	1	479
X+0475-0 500	1,436		21	49	123	880
X+0575-17500	844	18	14	52	80	79?
Total (Piece)	1,946,599	523,6 0	392.883	916,553	2,291,464	

4.2 Comparison operation process between current strategy and assemble-to-order strategy

After the review, the operation process identified the point where the process makes the difference to the final product. The concept is the point of assemble-to-order in the operation process. Figure 4.3 showed the current operation process starting from process received forecast from Asia Pacific, then defined the3 safety stock according to the inventory policy with all items managed by MTS. Chapter III mentioned Class C of HMC products will be determined as the point of ATO. Therefore, the real demand from actual orders received will drive the process at this point to the final products. Figure 4.4 presents a comparison of the operation process between the current strategy and the assemble to order strategy.

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Figure 4.3: The Existing Operation process

Person respond	Process	Description
Asia Pacific Logistics	Fore.: ast	Asia Pacifice send the forecast to plant
Distribution Planner	Difind Safety stocks	The Safety stock calculate base on inventory polic by ABC analysis all items keep in make to stock
Production	Manufacture	Production manufatering follow production planning programs
	HC Product / HMC Product	Production planning programs separate. according with the final products
	Injection / Injection	
	Hard coat / Ha d coat	
	Pack / Hard multicoated	
	Pack	
Warehouse	Inventory	Final products kept in inventory waiting actual orders from customer and then pick final products to prepare shipment to customers

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Figure 4.4: The ATO Operation process

Person respond	Process \ITS	Process MO	Description
	Start		
Asia Pacific Logistics	Forecast		Asia Pacifice send the forecast to plant
Distribution Planner	Difind Safety stock		The Safety stock calculate base on inventory policy 1) HC product make to stock all itmes plus demand of MK products class C 2) HMC products make to stock on class A, B
Production	nufacture		Production manufacture follow production planning programs
	HC Product / HMC Product		Production planning programs separate according with the final products 1) HC product following production planning program 2) HMC product class. A, B following productiong planning program
	Injection / Injection		
Customers	Hardcoat / Hardcoa	itde i	3) Customer place the orders to system
Distribution planner Warehouse Production	ulticoated	Inventor	4) New program for MO process when customer place the orders to system of HMC prouduct in class C 5) Warehouse pick assemble from stock according produciton planning program and send to production
	Pack / Pa k		
Warehouse			
Customers	ive itor		Final products kept in inventory wang actual orders from customer and then pick final products to prepare shipment to customers
Warehouse	Is Pick & Pack	Pick 2 Pack	6) After manufactured all itmes of ATO send to customer. The excess inventory will not created while prevent the obsolescence inventory
Customers			

4.3 Summary results of both strategies

Apparently, the results satisfy the objectives of the study and demonstrate that the company can practically apply an assemble-to-order strategy to determine appropriate safety stock policy for inventory Class C items of hard multicoated. The summary of key benefits in the research is given in Table. 4.4 The key objective are as follows:

Table 4.4: The summary of results

Description	As-Is		To-Be	
	HC product	HMC product	HC product	HMC product
Inventory Turn (unit days)	71	19	18	23
Inventory Value (unit $)	1,603,952	2,908,095	1,834,366	2,426,319
Cost of obsolesced Class A (unit $)	0	0	0	0
host of obsolesced Class B (unit $)	0	0	0	0
Cost of obsolesced Class C (unit $)	936,420	1,348,444	936,420	755,128
Day of supply (unit days)	89	78	64	65
umber of items inventory management	4932	12,444	4932	12,091

1) The cost of obsolescence inventory decreased by 593,316 dollars; the As-Is model shows 1,348,444 dollars, The model shows 755,128 dollars.

2) Days of supply have been improved for both products, by HC from 89 days to 64 days, and the **HMC** product from 78 days to 65 days.

3) Inventory of HC product increased 230,415 dollars, As-Is 1,603,951 dollars compared with To-Be as 1,834,366. But **HMC** decreases by 481,776 As-Is 2,908,095 dollars compared with To-Be as 2,426,319.

4) The number of items in inventory management decreased by 353 items.

Thus, the results of this implementation will prevent obsolescent stock as fast as possible. Also, there will be fast and more frequent inventory turnover, and importantly help the firm hold few inventories, which is the main objective of this resource. In the next chapter the conclusions and recommendations will be presented for further study.

CHAPTER V

SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The inventory cost is very important for the supply chain function. In this research we propose an alternative solution to prevent the obsolescence cost, by changing the inventory strategy from the MTS to the ATO strategy.

5.1 Summary of the findings

The objective of this research is to prevent obsolescence inventory cost by proposing an assemble-to-order strategy and minimize the inventory related cost since the company had been setting the inventory strategy by making-to-stock for all items.

To support the decision making of inventory management in order to minimize inventory cost and improve performance of inventory management, it is proposed that an assemble to order strategy be used for Class C items of the hard multicoated product.

Some level of inventory is necessary for an optimal process. Some of the rationale for holding inventories includes the following:

1. Inventory can be used to buffer against demand or operation process variability, resulting in stable manufacturing and production outputs.

2. The demand from market conditions may require rapid order fulfillment. That combined with manufacturing limitations and raw material limitations, may necessitate holding inventory at the assembly level

3. Inventory cost of assembly product is cheaper than final products.

Finally, a discussion in Chapter 4 was about the results of the resources for assemble to order which can prevent the company's obsolescence inventory by removing safety stock of final products and keeping the assemble items. Thus, the company can

implement the right strategy to meet customer's demand, which is also a response to the main objective of having an assemble to order strategy suitable for preventing an obsolescence inventory cost. Figure 5.1 show inventory cost for Class C items of hard multicoated products decreased, so it can help the firm to create a positive profit margin, while the days of supply also decrease.

Figure: 5.1 Inventory cost and days of supply comparison
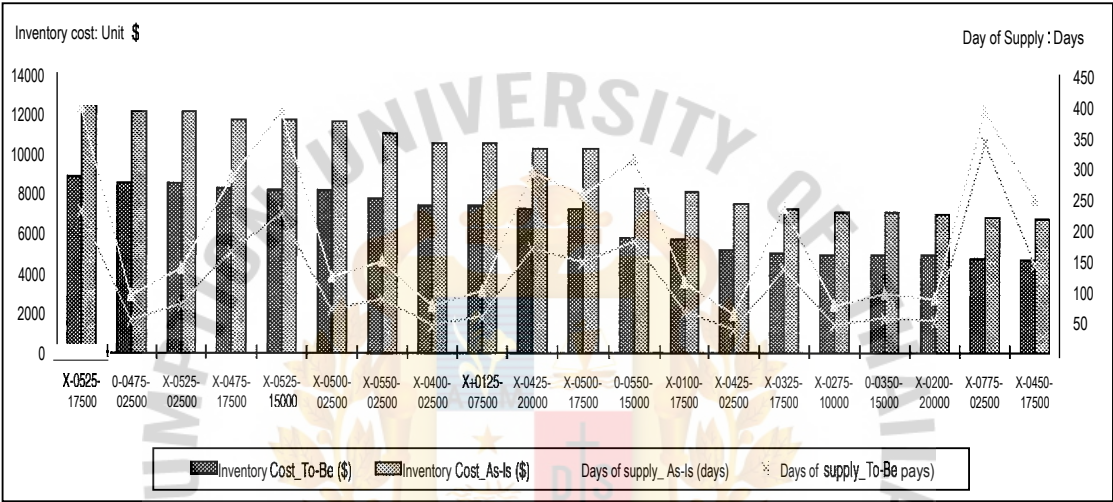
5.2 Conclusion

Inventory decision-making, on which items to manage by MTS, MTO or ATO is the important point of effect for inventory performance.

The primary results of ATO are to prevent obsolescence inventory cost, shorten manufacturing lead times, and increase reliability. In addition, ATO aids reduction of product development time and cost, helping to speed products to market. ATO is applicable in many contexts, but it requires appropriate organizational support and linkage with other tools to achieve the greatest benefits. Today's extraordinary level of international competition, coupled with the increased competitive significance of high quality new products that reach the market quickly, point to the need for understanding and applying critical new models such as common component inventory management for product variety changes.

Chapter 4 mentioned the result of inventory performance and the operation process. Thus, the firm can implement the suitable assemble to order strategy in order to prevent obsolescence inventory cost, and can separate the common products or processes. The more upstream point of view assemble to order can applied in the supply chain. This will reduce the demand uncertainty.

5.3 Recommendations for Further Research

It is highly recommended that this research be extended to other products by following the structure in Chapter 4. However, it is necessary to have a more fully trained cross-functional team to move around to where the work is for any particular product mix in the product family groups. The inventory analysis defines the group of common component by marking use of the forecast of demand distribution of the common assembly products. Further analyses of safety stock policy of the common components in the assembly to buffer demand uncertainly should be studied in detail item by item. This is applying the right strategy to manage these inventories by considering the common operation process to satisfy the customer demand based on a customer service level agreement.

This research focused on the internal supply chain regarding inventory management for finished products only. Further research could study the external supply chain at the suppliers' sites by collaborating with suppliers to use an assemble-to-order strategy aimed at delaying some supply chain activities until the true customer demand is revealed in order to prevent obsolescence inventory cost.

Finally, the company gains crucial benefit from this case study when the management key drivers are the cross-functional team. This becomes a common approach to addressing many supply management related activities, operating equipment, the acquisition of capital, problem solving, and development of strategies. Therefore, the result and implementation of this case study will strongly support the business and move it forward through a balanced level of inventory.

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APPENDICES

APPENDIX A

An example matrix of items of finished optical lenses

Matrix Items Finished Optical lenses

SPH/CYL	0.00	-0.25	-0.50	-0.75	-1.00	-1.25	50	5	-2.00
+4.00	C	C	C	C	C	C	C		
+3.75	C	C	C	C	C	C	C		C
+3.50	C	C	C	C	C	C	C	C	C
+3.25	C	C	C	C	C	C	C	C	C
+3.00	C	C	C	C	C	C	C	C	C
+2.75	C	C	C	C	C	C	C	C	C
+2.50	C	C	C	C	C	C	C	C	C
+2.25	C	C	C	C	C	C	C	C	C
+2.00	B	B	B	B	B	C	C	C	C
+1.75	B	B	B	B	B	C	C	C	C
+1.50	B	B	B	B	B	C	C	C	C
+1.25	B	B	B	B	B	C	C	C	C
+1.00	A	A	A	A	B	C	C	C	C
+0.75	A	A	A	A	B	C	C	C	C
+0.50	A	A	A	A	B	C	C	C	C
+0.25	A	A	A	A	B	C	C	C	C
0.00	A	A	A	A	B	C	C	C	C
-0.25	A	A	A	A	B	C	C	C	C
-0.50	A	A	A	A	B	C	C	C	C
-0.75	A	A	A	A	B	C	C	C	C
-1.00	A	A	A	A	B	C	C	C	C
-1.25	A	A	A	A	B	C	C	C	C
-1.50	A	A	A	A	B	C	C	C	C
75	A	A	A	A	B	C	C	C	C
	B	B	B	B	B	C	C	C	C
	B	B	B	B	B	C	C	C	C
-2.76	B	B	B	B	B	C	C	C	C
-3.00	B	B	B	B	B	C	C	C	C
-3.2	B	B	B	B	B	C	C	C	C
-3.50	B	B	B	B	B	C	C	C	C
-4.00	C	C	C	C	C	C	C	C	C
-4.25	C	C	C	C	C	C	C	C	C
-4.50	C	C	C	C	C	C	C	C	C
-4.75	C	C	C	C	C	C	C	C	C
-5.00	C	C	C	C	C	C	C	C	C
-5.25	C	C	C	C	C	C	C	C	C
-5.50	C	C	C	C	C	C	C	C	C
-5.75	C	C	C	C	C	C	C	C	C
-6.00	C	C	C	C	C	C	C	C	C
-6.25	C	C	C	C	C	C	C	C	
-6.50	C	C	C	C	C	C	C		
6	C	C	C	C	C	C			
)0	C	C	C	C	C				
-7.25	C	C	C	C					
-7.50	C	C	C						
	C								
8.00	C								

= Items x+0375-1750

APPENDIX B

Safety stock level by classification
1) Safety stock for Class A items

Items in class A generate the sale value of 21million dollars which is 60% of accumulated annual sale and numbers 66 items (13.55 % of total items).

Table 3.3 Safety stock for Class A

Items code	Annual Sale value (5)	Quantity on Monthly sale	% of Annual Sale	% of Accumulate annual Sale	Class	Safety stock	Target coverage sale
X-0100-00000	863,666	62,045	2.38%	2.38%	A	62,045	1
X-0200-00000	802,224	57,631	2.21%	4.59%	A	57,631	1
X-0125-00000	775,024	55,677	2.14%	6.73%	A	55,677	1
X-0075-00000	766,045	55,032	2.11%	8.85%	A	55,032	1
X-0150-00000	766,045	55,032	2.11%	10.96%	A	55.032	1
X-0175-00000	677,152	48,646	1.87%	12.83%	A	48,646	1
X+0000-00000	642,366	46,147	1.77%	14.60%	A	46,147	1
X-0050-00000	636,548	45,729	1.76%	16.35%	A	45,729	1
X+0050-00000	538,453	38,682	1.49%	17.84%	A	38,682	1
X+0075-00000	535.127	38,443	1.48%	19.32%	A	38,443	1
X-0225-00000	512.242	36,799	1.41%	20.73%	A	36,799	1
X-0250-00000	511 599	36,760	1.41%	22.14%	A	36,760	1
X-0300-00000	460,293	33,067	1.27%	23.41%	A	33,067	1
X-0275-00000	434,805	31,236	1.20%	24.61%	A	31,236	1
X+0000-05000	424,769	30,515	1.17%	25.78%	A	30,515	1
X-0050-05000	392,697	28,211	1.08%	26.86%	A	28,211	1
X-0100-05000	391 596	28,096	1.08%	27.94%	A	28,096	1
X-0075-05000	381 505	27,407	1.05%	28.99%	A	27,407	1
X+0100-00000	366,082	26.299	1.01%	30.00%	A	26,299	1
X-0325-00000	360,584	25,904	0.99%	31.00%	A	25,904	1
X+0000-07500	348,780	25,056	0.96%	31.96%	A	25,056	
X-0350-00000	344.715	24,764	0.95%	32.91%	A	24,764	
X-0125-05000	340,107	24,433	0.94%	33.85%	A	24,433	1
X-0150-05000	335,931	24,133	0.93%	34.78%	A	24,133	1
X-0175-05000	293,072	21,054	0.81%	35.58%	A	21,054	1
5-0375-00000	284,274	20,422	0.78%	36.37%	A	20,422	1
X-0400-00000	283.369	20,357	0.78%	37.15%	A	20,357	
5-0100-02500	282,451	20,291	0.78%	37.93%	A	20,291	1
X-0200-05000	276,980	19,898	0.76%	38.69%	A	19,898	1
X-0075-02500	275.491	19,791	0.76%	39.45%	A	19,791	1
5-0025-05000	271,872	19,531	0.75%	40.20%	A	19,531	1
5+0150-00000	263,547	18,933	0.73%	40.93%	A	18,933	
5-0050-02500	255,696	18,369	0.71%	41.64%	A	18,369	
5+0050-05000	247289	17,765	0.68%	42.32%	A	17,765	1
5-0125-02500	246,245	17,690	0.68%	43.00%	A	17,690	1
5-0225-05000	242,834	17,445	0.67%	43.67%	A	17,445	1
5-0025-00000	242,055	17,389	0.67%	44.33%	A	17,389	1
X+0000-10000	241,944	17,381	0.67%	45.00%	A	17,381	
X+0200-00000	239,577	17,211	0.66%	45.66%	A	17,211	1
X+0125-00000	235,860	16,944	0.65%	46.31%	A	16,944	1
5-0250-05000	230,835	16 583	0.64%	46.95%	A	16.583	1
5-0150-02500	221,077	15,882	0.61%	47.56%	A	15,882	1
X-0300-05000	210,707	15,137	0.58%	48.14%	A	15,137	
5-0425-00000	210,679	15,135	0.58%	48.72%	A	15,135	1
5-0050-07500	209,747	15,068	0.58%	49.30%	A	15,068	1
X+0300-00000	209,218	15,030	0.58%	49.88%	A -	15.030	1
X-0450-00000	209,134	15,024	0.58%	50.45%	A	15,024	1
X-0075-137500	206,239	14,816	0.57%	51.02%	A	14,816	1
5-0100-07500	205,640	14,773	0.57%	51.59%	A	14,773	1
X+0250-00000	199,849:	14,357	0.55%	52.14%	A	14,357	1
X+0175-00000	197,455	14,185	0.54%	52.69%	A	14,185	1
5-0275-05000	193,766.	13,920	0.53%	53.22%	A	13,920	1
5-0175-02500	188,797	13,563	0.52%	53.74%	A	13,563	1
5-0325-05000	185,345	13,315	0.51%	54.25%	A	13,315	1
X+0075-05000	182,185	13 088	0.50%	54.76%	A	13,088	1
X+0025-05000	181,336	13,027	0.50%	55.26%	A	13,027	1
5+0000-02500	179,067	12,864	0.49%	55.75%	A	12,864	1
5-0025-07500	176.881	12.707	0.49%	56.24%	A ...	12,707	1
5-0025-02500	175,462	12,605	0.48%	56.72%	A	12,605	1
5-0200-02500	175,253	12,590	0.48%	57.20%	A	12,590	1
5-0125-07500	168,223	12,085	0.46%	57.67%	A	12,085	1
5-0150-07500	165,926	11,920	0.46%	58.13%	A	11,920	1
5-0350-135000	165,745	11,907	0.46%	58.58%	A	11,907	
5-0500-00000	162,669	11,686	0.45%	59.03%	A	11,686	1
5+0000-12500	161 506	11,624	0.45%	59.48%	A	11,624	1
X+0225-00000	157,366	11,305	0.43%	59.91%	A	11,305	1
Total	21,120,921						

APPENDIX C

Safety stock level by classification

2) Safety stock for Class B items

Items in class B generate the sale value of 7.2 million dollars which is 20% of accumulated annual sale and numbers 68 items (13.96 % of total items).

Table 3.4 Example Safety stock for Class B items

Items code	Annual Sale value ($)	Quantity on Monthly sale	% of Annual Sale	% of Accumulate annual Sale	Class	Safety stock	Target coverage sale
X-0225-02500	156,809	11.265	0.43%	60.34%	B	22,530	
X+0075-02500	155,709	11,186	0.43%	60.77%	B	22,372	2
X-0475-00000	155,208	11,150	0.43%	61.20%	B	22,300	2
X+0025-07500	153,802	11 049	0.42%	61.63%	B	22,098	2
X+0050-02500	152,452	10,952	0.42%	62.05%	B	21,904	2
X-0175-07500	149,487	10,739	0.41%	62.46%	B	21,478	2
X-0200-07500	145,742	10,470	0.40%	62.86%	B	20,940	2
X-0025-00000	143,390	10,301	0.40%	63.26%	B	20,602	2
X+0050-07500	139,367	10,012	0.38%	63.64%	B	20,024	2
X+0100-05000	138,810	9,972	0.38%	64.02%	B	19,944	2
X-0100-10000	136,110	9,778	0.38%	64.40%	B	19,556	2
X-0375-05000	135,400	9,727	0.37%	64.77%	B	19,454	2
X-0400-05000	132,936	9,550	0.37%	65.14%	B	19,100	2
X-0050-10000	132,268	9,502	0.36%	65.50%	B	19,004	2
X-0250-02500	129,929	9,334	0.36%	65.86%	El	18,668	2
X-0550-00000	127,980	9,194	0.35%	66.22%	B	18,388	2
X-0250-07500	127,716	9.175	0.35%	66.57%	B	18,350	2
X-0225-07500	126,060	9,056	0.35%	66.92%	B	18,112	2
X-0300-07500	122,134	8,774	0.34%	67.25%	B	17,548	2
X+0000-15000	121,925	8,759	0.34%	67.59%	B	17,518	2
X-0075-10000	121,563	8,733	0.34%	67.92%	B	17,466	2
X+0075-07500	119,809	8,607	0.33%	68.26%	B	17,214	2
X+0275-00000	118,584	8,519	0.33%	68.58%	B	17,038	2
X-0025-10000	117,916	8,471	0.33%	68.91%	B	16,942	2
X-0300-02500	114,798	8,247	0.32%	69.22%	B	16.494	2
X-0275-07500	111.360	8.000	0.31%	69.53%	B	16,000	2
X-0275-02500	109,912	7,896	0.30%	69.83%	B........	15,792	2
X-0425-05000	108,687	7,808	0.30%	70.13%	B	15,616	2
X+0025-02500	108,604	7,802	0.30%	70.43%	B	15.504	2
X-0150-10000	105,207	7,558	0.29%	70.72%	B	15,116	2
X+0150-05000	104,748	7,525	0.29%	71.01%	B	15,050	2
X-0450-05000	103,593	7,442	0.29%	71.30%	B	14,884	2
X+0125-05000	103,175	7,412	0.28%	71.58%	B	14,824	2
X-0125-10000	101,769	7,311	0.28%	71.86%	B	14,622	2
X-0325-02500	101.365	7.282	0.28%	72.14%	B	14,564	2
X-0525-00000	100,795	7241	0.28%	72.42%	B	14,482	2
X+0100-02500	100,210	7199	0.28%	72.70%	B	14,398	2
X+0050-10000	99,514	7,149	0.27%	72.97%	B	14,298	2
X-0200-10000	97,872	7.031	0.27%	73.24%	B	14,062	2
X-0350-07500	97,732	7,021	0.27%	73.51%	B	14,042	2
X-0325-07500	97,524	7,006	0.27%	73.78%	B	14,012	2
X-0600-00000	95,937	6,892	0.26%	74.05%	B	13,784	2
X-0175-10000	94,503	6,789	0.26%	74.31%	B	13.578	2
X+0200-05000	93,250	5.699	0.26%	74.56%	B	13,398	2
X+0175-05000	90,424	6,496	0.25%	74.81%	B	12,992	2
X+0025-10000	90,299	6,487	0.25%	75.06%	B	12,974	2
X+0000-20000	88,002	6,322	0.24%	75.30%	B	12,644	2
X-0350-02500	87,738	6,303	0.24%	75.55%	B	12,606	2
X+0100-10000	86,081	6,184	0.24%	75.78%	B	12,368	2
X-0300-10000	84,522	6,072	0.23%	76.02%	B	12,144	2
X-0250-10000	84,160	6,046	0.23%	76.25%	B	12,092	2
X-0050-12500	83,590	6,005	0.23%	76.48%	B	12,010	2
X+0250-05000	81.766	5.874	0.23%	76.71%	B	11,748	2
X-0225-10000	81,223	5,835	0.22%	76.93%	B	11,670	2
X-0100-12500	80,652	5,794	0.22%	77.15%	B	11,588	2
X-0400-07500	79,553	5,715	0.22%	77.37%	B	11,430	2
X+0000-17500	79,511	5,712	0.22%	77.59%	B	11.424	2
X-0025-12500	79,414	5,705	0.22%	77.81%	B	11,410	2
X-0075-12500	78,509	5,640	0.22%	78.03%	B	11,280	2
X-0375-02500	78,300	5,625	0.22%	78.24%	B	11,250	2
X-0475-05000	77,938	5,599	0.21%	78.46%	B	11,198	2
X-0375-07500	77,409	5,561	0.21%	78.67%	B	11,122	
X+0225-05000	76,727	5,512	0.21%	78.88%	B........	11,024	
X+0100-07500	75,767	5,443	0.21%	79.09%	B	10,886	
X+0125-02500	74,124	5,325	0.20%	79.30%	B	10,650	
X+0075-10000	72,412	5,202	0.20%	79.50%	B	10,404	
X+0350-00000	72,217	5,188	0.20%	79.69%	B	10,376	2
X-0500-05000	72,078	5,178	0.20%	79.89%	B	10,356	2
Total	7,244,079						

APPENDIX D

Safety stock level by classification

3) Safety stock for Class C items

Items class C presented in Table 3.5 generate the sale value of 7 2 million dollars which is 20 % of revenue, and has 353items (72.48 % of total items).

Table 3.5 Safety stock for Class C items

Items code	Annual Sale value	Quantity on Monthly sale	% of Annual Sale	% of Accumulate annual Sale	Class	Safety stock	Target coverage sale
X-0575-00000	71,911	5,166	0.20%	80.09%	C	 12,915	2.5
X*0150-02500	70,950	5,097	0.20%	80.29%	C	12,743	2.5
X-0275-10000	69,976	5,027	0.19%	80.48%	C	12,568	2.5
X-0125-12500	69,823	5,016	0.19%	80.67%	C	12,540	2.5
X-0400-02500	68,403	4,914	0.19%	80.86%	C	12,285	2.5
X-0150-12500	68,041	4,888	0.19%	81.05%	C	12,220	2.5
X-0350-10000	66,969	4,811	0.18%	81.23%	C	12,028	2.5
X+0050-12500	66,732	4,794	0.18%	81.42%	C	11,985	2.5
X-0325-10000	66,719	4,793	0.18%	81.60%	C	11,983	2.5
X+0125-07500	65,995	4,741	0.18%	81.78%		11,853	2.5
X+0025-12500	65,494	4,705	0.18%	81.97%		11,763	2.5
X-0425-07500	65.062	4,674	0.18%	82.14%	C	11,685	2.5
X+0300-05000	64,575	4,639	0.18%	82.32%		11,598	2.5
X-0425-02500	64,116	4,606	0.18%	82.50%	C	11,515	2.5
X+0325-00000	63,587	4,568	0.18%	82.67%		11,420	2.5
X+0275-05000	62,598	4,497	0.17%	82.85%	C	11 .243	2.5
X-0450-07500	62,069	4,459	0.17%	83.02%	C	11,148	2.5
X-0050-15000	61 .944	4,450	0.17%	83.19%	C	11,125	2.5
X-0200-12500	61,624	4,427	0.17%	83.36%	C	11,068	2.5
X+0175-02500	60,093	4,317	0.17%	83.53%	C	10,793	2.5
X-0175-12500	59,675	4,287	0.16%	83.69%	C	10,718	25
X.0200-02500	59,299	4,260	0.16%	83.85%	C	10.650	25
X-0400-10000	59,049	4,242	0.16%	84.02%	C	10,605	2.5
X+0150-07500	58,227	4,183	0.16%	84.18%	C	10,458	2.5
X-0375-10000	56,640	4,069	0.16%	84.33%	C	10,173	2.5
X+0400-00000	55,068	3,956	0.15%	84.49%	C	9,890	2.5
X*0200-07500	54,956	3,948	0.15%	84.64%	C	9,870	2.5
X-0225-12500	54,399	3,908	0.15%	84.79%	C	9,770	2.5
X*0175-07500	53,884	3,871	0.15%	84.94%	C	9,678	2.5
X-0025-15000	53,286	3,828	0.15%	85.08%	C	9,570	2.5
X*0075-12500	52,381	3,763	0.14%	85.23%	C	9,408	2.5
X-0100-15000	51,908	3,729	0.14%	85.37%	C	9,323	2.5
X-0250-12500	51,615	3,708	0.14%	85.51%	C	9,270	2.5
X-0450-02500	51,574	3,705	0.14%	85.65%	C	9,263	2.5
X+0150-10000	51,546	3,703	0.14%	85.80%	C	9,258	2.5
X+0225-02500	51,017	3,665	0.14%	85.94%	C	9,163	2.5
X-0300-12500	50,112	3,600	0.14%	86.08%	C	9.000	2.5
X+0100-12500	49,444	3,552	0.14%	86.21%	C	8,880	2.5
X+0050-15000	49,179	3.533	0.14%	86.35%	C	8,833	2.5
X-0475-07500	48.497	3,484	0.13%	86.48%	C	8,710	2.5
X+0025-15000	48,302	3,470	0.13%	86.61%	C	8,675	2.5
X-0525-05000	48,288	3,469	0.13%	86.75%	C	8,673	2.5
X-0275-12500	48,010	3,449	0.13%	86.88%	C	8,623	2.5
X-0550-05000	47,662	3,424	0.13%	87.01%	C	8,560	2.5
X+0125-10000	47,036	3,379	0.13%	87.14%	C	8.448	2.5
X-0075-15000	46,883	3,368	0.13%	87.27%	C	8.420	2.5
X+0250-02500	46,479	3,339	0.13%	87.40%	C	8,348	2.5
X-0150-15000	46,228	3,321	0.13%	87.53%	C	8,303	2.5
X.0125-12500	46,187	3,318	0.13%	87.65%	C	8,295	2.5
X-0500-07500	46,006	3,305	0.1 3%	87.78%	C	8,263	2.5
X+0250-07500	45,115	3,241	0.12%	87.91%	C	8,103	2.5
X-0425-10000	44,280	3,181	0.12%	88.03%	C	7,953	2.5
X+0225-07500	43,514	3.126	0.12%	88.15%	C	7,815	2.5
X+0150-15000	43,486	3,124	0.12%	88.27%	C	7,810	2.5
X+0200-10000	43,347	3,114	0.1 2%	88.39%	C	7,785	2.5
X-0450-10000	42,818	3,076	0.12%	88.51%	C	7,690	2.5
X-0475-02500	42,651	3,064	0.12%	88.62%	C	7,660	2.5
X-0200-15000	42,136	3,027	0.12%	88.74%	C	7,568	2.5
X+0375-00000	42,011	3,018	0.12%	88.85%		7,545	2.5
X-0350-12500	41,426	2,976	0.11%	88.97%	C	7,440	2.5
X-0125-15000	41,398	2,974	0.11%	89.08%	C	7.435	2.5
X+0350-05000	41,148	2.956	0.11%	89.20%	C	7,390	2.5
X-0325-12500	40.925	2,940	0.11%	89.31%	C	7,350	2.5
X-0175-15000	39,992	2,873	0.11%	89.42%	C	7,183	2.5
X+0175-10000	39,408	2,831	0.11%	89.53%	C	7,078	2.5
X+0325-05000	39,408	2,831	0.11%	89.64%	C	7,078	2.5
X-0250-15000	38,739	2,783	0.11%	89.74%	C	6,958	2.5
X*0075-15000	38,183	2,743	0.11%	89.85%	C	6.858	2.5
X+0275-07500	37,668	2,706	0.10%	89.95%	C	6,765	2.5
X+0275-02500	37,111	2,666	0.1 0%	90.06%	C	6,665	2.5

Items coda	Annual Sale value ($)	Quantity ion Monthly sale	% of Annual Sale	% of Accumulate annual Sale	Class	Safety stock	Target coverage sale
X-0375-12500	36,763	2,641	0.10%	90.16%	C........	6,093	2.5
X+0300-97500	36,665	2,634	010%	90 26%	C	6,585	2.5
X-0400-12500	:36,345	2.611	0.10%	90.36%	C	6,528	2.5
X-0050-17500	36,150	2,597	0.10%	90.46%	C	6,493	2.5
X +0250-10000	35,566	2,555	0.10%	90.56%	C	6,368	2.5
X+0100-15000	35,468	2,548	010%	90.65%	C	6,370	2.5
X-0500-10000	35,454	2,547	0.10%	90.75%	C	6.368	2.5
X-0050-20000	35,343	2,539	0.10%	90.85%	C	 6,348	2.5
X-0025-17500	34,772	2,498	0.10%	90.95%	C	6,245	2.5
X-0300-15000	34,118	2,451	0.09%	91 .04%	C	6,128	2.5
X-0225-15000	33,032	2,373	009%	91 13%	I..	5,933	5
X-0700-00000	32,921	2,365	0.09%	91 .22%	C	5,913	2.5
X+0150-12500	32,684	2,348	0.09%	91 31%	C	5,870	2.5
X-0500-02500	32,684	2,348	0.09%	91 .40%	C	5,870	2.5
X -0475-10000	32,528	2,344	0.09%	91.49%	C	5,860	2.5
X-0075-17500	32,211	2,314	0_09%	91 .58%	C	5,785	2.5
X-0525-07500	31,974	2,297	0.09%	91.67%	C	5,743	2.5
X+0050-17500	31,668	2,275	0.09%	91 .76%	C	5,668	2.5
X +0050-2000 0	31417	2,257	0.09%	91 .84%		5,643	2.5
X-0650-00000	31,362	2,253	0.09%	91 .93%	C	5.633	2.5
X-0350-15000	31,139	2,237	0.09%	92.02%		5,593	2.5
X +0025-17500	30,688	2,219	0.09%	92.10%	C	5,548	2.5
X 0025 20000	30,791	2,212	0.08%	92.19%	C	5,530	2.5
X-0425-12500	30,652	2,202	0.08%	92.27%	C	5,505	2.5
X+0300-02500	30,610	2,199	0118%	92.35%	C	5,498	2.5
X-0100-20000	30,527	2,193	0.08%	92.44%	C	5,4133	2.5
X 0300-1000 0	30,4-57	2,188	OM%	02.52%	C	5,470	2.5
X-0100-17500	30,151	2,166	0.08%	92.61%	C	5,415	2.5
X-0525-00000	30,095	2,162	0.08%	92.69%	C	5,405	2.5
X-0275-15000	29,970	2,153	0.08%	92.77%	C	5,383	2.5
X+0225-10000	29,709	2,140	0.00%	92.05%	C	5,350	2.5
X-0150-17500	29,288	2,104	0.08%	92.93%	C	5,260	2.5
X-0325-15000	29,135	2,093	0_08%	93.01%	C	5,233	2.5
X-0200-17500	28,327	2,035	0_08%	93.09%	C	5,088	2.5
X -0175-1 7500	20,100	2,025	0.00%	93.17%	C	5,003	2.5
X-0075-20000	28,160	2,023	0.08%	93.25%	C	5,058	2.5
X-0450-12500	28,077	2,017	0.08%	93.33%	C	5,043	2.5
X-0575-05000	28,049	2,015	0.08%	93.40%	C	5,038	2.5
X+0175-12500	27,784	1,998	008%	93.48%	C	4,990	2.5
X-0200-20000	27,770	1,995	0_08%	93.56%	C	4,9138	2.5
X-0125-17500	27,673	1,988	0.08%	93.63%	C	4,970	2.5
X+0325-07500	27,569	1,982	0.06%	93.71%	C	4,955	2.5
X +0200-2000 0	27,478	1.974	0.08%	93.78%	1.	4,935	2.5
X-0600-05000	27,367	1,966	0.08%	93.86%	C	4.915	2.5
X+0200-15000	27,353	1,965	0118%	93.94%	C	4,913	2.5
X-0525-02500	26,796	1,925	0.07%	94 01%	C	4,813	2.5
X-0400-15000	26,671	1,916		94.08%		4,790	2.5
X+0125-15000	26,615	1,912	0.07%	94.16%	C	4,780	2.5
X+0075-17500	26,337	1,692	0.07%	94.23%	C	4,730	2.5
X+0200-12500	26,337	1,892	0.07%	94.30%	C	4,730	2.5
X+0025-20000	26,003	1,868	0.07%	94.37%	C	4,670	2.5
X+0100-20000	25,710	1,847	0_07%	94.44%	C	4,618	2.5
X+0375-05000	25,599	1,839	0.07%	94.51%	C	4,598	2.5
X+0275-10000	25,557	1,836	0.07%	94.59%	C	4,590	2.5
X-0150-20000	25,515	1,833	0.07%	94.66%	C	4,563	2.5
X-0125-20000	24,847	1,785	0.07%	94.72%	C	4.453	2.5
X-0550-02500	23,984	1,723	0.07%	94.79%	C	4,308	2.5
X+0175-15000	23,031	1,712	0.07%	94.86%	C	4,280	2.5
X-0225-17500	23.603	1,710	0.07%	94.92%	C	4,275	2.5
X+0350-07500	23,692	1,702	0.07%	94 99%	C	4,255	2.5
X-0375-15000	23,539	1,691	0.06%	95.05%	C	4,228	2.5
X+0075-20000	23,511	1,689	0.06%	95.12%	C	4,223	2.5
X+0100-17500	23,191	1,666	0.06%	95.18%	C	4,155	2.5
X-0475-12500	23,093	1,659	0.06%	95.24%	C	4,148	2.5
X-0450-15000	23,024	1,654	0 06%	95.31:6	C	4,135	2 5
X-0550-07500	23,010	1,653	0.06%	95.37%	C	4,133	2.5
X-0250-17500	22,648	1,627	0.06%	95.43%	C	4,058	2.5
X-0300-17500	22,634	1,626	0.06%	95.50%	C	4,065	2.5

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Items code	Annual Sale value ($)	Quantity on Monthly sale	% of Annual Sale	% of Accumulate annual Sale		Safety stock	Target coverage sale
X-0425-15000	22,272	1 .600	0.06%	95.56%	C	4,000	2.5
X-0175-20000	21,548	1,548	0.06%	95.62%	C	3,870	2.5
X+0325-02500	21,270	1,528	0.06%	95.68%	C	3,820	2.5
X-0675-00000	21,019	1,510	0.06%	95.73%	C	3,775	2.5
X-0250-20000	20,950	1,505	0.06%	95.79%	C.......	3,763	2.5
X+0250-12500	20,838	1,497	0.06%	95.85%	C	3,743	2.5
X+0150-20000	20,727	1,489	0.06%	95.91%	C	3,723	2.5
X-0225-20000	20,685	1,486	0.06%	95.96%	C	3,715	2.5
X-0300-20000	20,657	1,484	0.06%	96.02%	C	3,710	2.5
X+0175-17500	20,337	1,461	0.06%	96.08%	C	3,653	2.5
X-0275-17500	20,323	1,460	0.06%	96.13%	C	3,650	2.5
X+0350-10000	20,254	1,455	0.06%	96.19%	C	3,638	2.5
X+0400-05000	19,947	1,433	0.06%	96.24%	C	3,583	2.5
X+0225-12500	19,613	1,409	0.05%	96.30%	C	3,523	2.5
X+0250-15000	19,377	1,392	0.05%	96.35%	C	3.480	2.5
X+0150-17500	19,293	1,386	0.05%	96.40%	C	3,465	2.5
X+0375-07500	18,973	1,363	0.05%	96.46%	C	3,408	2.5
X+0125-20000	18.486	1,328	0.05%	96.51%	C	3,320	2.5
X-0550-10000	18,486	1,328	0.05%	96.56%	C	3,320	2.5
X-0325-17500	18,360	1,319	0.05%	96.61%	C	3,298	2.5
X-0600-07500	18,249	1,311	0.05%	96.66%	C	3,278	2.5
X-0350-17500	18,096	1,300	0.05%	96.71%	C	3,250	2.5
X-0575-07500	18,096	1,300	0.05%	96.76%	C.......	3,250	2.5
X+0325-10000	17,915	1,287	0.05%	96.81%	C	3,218	2.5
X-0575-02500	17,845	1,282	0.05%	96.86%	C - - -	3,205	2.5
X+0125-17500	17.720	1 .273	0.05%	96.91%	C.......	3,183	2.5
X+0300-15000	17,539	1,260	0.05%	96.96%	C	3,150	2.5
X-0625-05000	17,525	1,259	0.05%	97.00%	C	3,148	2.5
X-0400-17500	17,344	1,246	0.05%	97.05%	C	3,115	2.5
X-0650-05000	17.316	1,244	0.05%	97.10%	C	3,110	2.5
X+0225-15000	17,233	1,238	0.05%	97.15%	:C	3,095	2.5
X-0275-20000	17,205	1,236	0.05%	97.19%	:C	3,090	2.5
X+0300-12500	16,815	1,208	0.05%	97.24%	C	3,020	2.5
X+0350-02500	16,815	1,208	0.05%	97.29%	C	3,020	2.5
X+0275-12500	16,704	1,200	0.05%	97.33%	C	3,000	2.5
X-0325-20000	15,938	1,145	0.04%	97.38%	C	2,863	2.5
X-0600-10000	15,938	1,145	0.04%	97.42%		2,863	2.5
X-0500-12500	15,924	1,144	0.04%	97.46%	C	2.860	2.5
X-0400-20000	15,883	1,141	0.04%	97.51%	C	2,853	2.5
X-0350-20000	15,841	1,138	0.04%	97.55%	C - - - - -	2,845	2.5
X-0750-00000	15,799	1,135	0.04%	97.60%	C.......	2,838	2.5
X-0425-17500	15,618	1,122	0.04%	97.64%	C	2,805	2.5
X-0525-10000	15,563	1,118	0.04%	97.68%	C	2,795	2.5
X-0375-17500	15,521	1,115	0.04%	97.72%	C	2,788	2.5
X+0200-17500	15,493	1,113	0.04%	97.77%	C	2,783	2.5
X-0725-00000	15,396	1,106	0.04%	97.81%	C	2,765	2.5
X-0600-02500	14,407	1,035	0.04%	97.85%	C	2,588	2.5
X+0400-07500	14,157	1,017	0.04%	97.89%	C	2,543	2.5
X-0375-20000	13,823	993	0.04%	97.93%	C	2,483	2.5
X+0375-10000	13,321	957	0.04%	97.96%	C	2,393	2.5
X-0575-10000	13,280	954	0.04%	98.00%	C	2,385	2.5
X+0400-10000	12,932	929	0.04%	98.04%		2,323	2.5
X+0175-20000	12,834	922	0.04%	98.07%	C	2,305	2.5
X-0625-07500	12,598	905	0.03%	98.11%	C	2,263	2.5
X-0675-05000	12,444	894	0.03%	98.14%	C	2,235	2.5
X-0650-07500	12,403	891	0.03%	98.17%	C	2,228	2.5
X-0500-15000	12.250	880	0.03%	98.21%	C	2,200	2.5
X-0525-12500	12,236	879	0.03%	98.24%	C	2,198	2.5
X-0800-00000	12,222	878	0.03%	98.28%	C	2,195	2.5
X-0475-15000	12,166	874	0.03%	98.31%	C	2,185	2.5
X+0275-15000	12,138	872	0.03%	98.34%	C	2,180	2.5
X-0700-05000	11,957	859	0.03%	98.38%	C	2,148	2.5
X-0550-12500	11,345	815	0.03%	98.41%	C	2,038	2.5
X+0325-12500	11,247	808	0.03%	98.44%	C	2,020	2.5
X+0225-17500	11,150	801	0.03%	98.47%	C	2,003	2.5
X-0625-02500	10,830	778	0.03%	98.50%		1,945	2.5
X+0250-20000	10,802	776	0.03%	98.53%	C	1 ,940	2.5
X+0375-02500	10,746	772	0.03%	98.56%	C	1,930	2.5
X+0225-20000	10,524	756	0.03%	98.59%		1,890	2.5

Items code	Annual Sale value ($)	Quantity on Monthly sale	% of Annual Sale	% of Accumulate annual Sale	Class	Safety stock	Target coverage sale
X+0300-20000	10,496	754	0.03%	98.62%	C	1,885	2.5
X-0450-17500	10,454	751	0.03%	98.65%	C	1,878	2.5
X+0350-15000	10,343	743	0.03%	98.67%	C	1,858	2.5
X+0350-12500	10,245	736	0.03%	98.70%	C	1,840	2.5
X+0250-17500	9,939	714	0.03%	98.73%		1,785	2.5
X-0650-10000	9,814	705	0.03%	98.76%		1,763	2.5.
X-0475-17500	9,758	701	0.03%	98.78%	C	1,753	2.5
X-0775-00000	9,577	688	0.03%	98.81%	C	1,720	2.5
X-0575-12500	8,992	646	0.02%	98.83%	C	1,615	2.5
X-0500-17500	8,964	644	0.02%	98.86%	C	1,610	2.5
X-0450-20000	8,700	625	0.02%	98.88%	C	1,563	2.5
X-0650-02500	8,616	619	0.02%	98.91%		1,548	2.5
X-0625-10000	8,603	618	0.02%	98.93%		1,545	2.5
X+0400-02500	8547	614	0.02%	98.95%	C	1,535	2.5
X+0400-12500	8519	612	0.02%	98.98%	C	1,530	2.5
X-0600-12500	8,491	610	0.02%	99.00%	C	1,525	2.5
X-0550-15000	8,463	608	0.02%	99.02%	C	1,520	2.5
X+0325-15000	8,436	606	0.02%	99.05%	C	1,515	2.5
X+0375-12500	8,422	605	0.02%	99.07%	C	1,513	2.5
X-0675-07500	8,408	604	0.02%	99.09%	C	1,510	2.5
X-0750-05000	8,352	600	0.02%	99.12%		1,500	2.5
X+0400-15000	8,101	582	0.02%	99.14%	C	1,455	2.5
X-0725-05000	8.032	577	0.02%	99.16%	C	1,443	2.5
X-0425-20000	7,962	572	0.02%	99.18%	C	1,430	2.5
X-0700-07500	7,948	571	0.02%	99.21 %:	C	1,428	2.5
X+0350-20000	7,614	547	0.02%	99.23%	C	1,368	2.5
X-0525-15000	7,600	546	0.02%	99.25%		1,365	2.5
X+0275-17500	7,461	536	0.02%	99.27%	C	1,340	2.5
X-0500-20000	7,447	535	0.02%	99.29%	C	1.338	2.5
X+0300-17500	7,419	533	0.02%	99.31%		1,333	2.5
X-0475-20000	8,974	501	0.02%	99.33%	C	1,253	2.5
X-0600-15000	6,946	499	0.02%	99.35%	C	1,248	2.5
X-0675-02500	6,946	499	0.02%	99.37%	C	1,248	2.5
X+0275-20000	6,765	486	0.02%	99.39%	C	1,215	2.5
X-0600-20000	6,682	480	0.02%	99.40%	C	1,200	2.5
X-0700-10000	6,612	475	0.02%	99.42%	C	1,188	2.5
X+0325-17500	6,584	473	0.02%	99.44%	C	1,183	2.5
X-0700-02500	6,515	468	0.02%	99.46%	C	1,170	2.5
X-0675-10000	6,389	459	0.02%	99.48%	C	1,148	2.5
X-0525-20000	6,361	457	0.02%	99.49%	C	1,143	2.5
X-0725-07500	6,320	454	0.02%	99.51%	C	1,135	2.5
X+0375-15000	6,250	449	0.02%	99.53%	C	1,123	2.5
X-0550-17500	6,167	443	0.02%	99.55%	C	1,108	2.5
X-0575-15000	5,986	430	0.02%	99.56%	C	1,075	2.5
X-0625-12500	5,986	430	0.02%	99.58%	C	1,075	2.5
X+0375-17500	5,846	420	0.02%	99.59%	C	1,050	2.5
X-0525-17500	5,777	415	0.02%	99.61%	C	1,038	2.5
X+0400-20000	5,763	414	0.02%	99.63%	C	1,035	2.5
X-0550-20000	5,707	410	0.02%	99.64%	C	1,025	2.5
X+0350-17500	5,693	409	0.02%	99.66%	C	1,023	2.5
X-0650-12500	5,582	401	0.02%	99.67%	C	1,003	2.5
X+0325-20000	5,540	398	0.02%	99.69%	C	995	2.5
X-0650-15000	5,373	386	0.01%	99.70%	C	965	2.5
X-0600-17500	5,276	379	0.01%	99.72%	C	948	2.5
X+0375-20000	5,109	367	0.01%	99.73%	C	918	2.5
X-0750-02500	4,830	347	0.01%	99.74%	C	868	2.5
X-0575-17500	4,719	339	0.01%	99.76%	C	848	2.5
X-0725-02500	4,719	339	0.01%	99.77%	C	848	2.5
X-0625-15000	4,552	327	0.01%	99.78%	C	818	2.5
X+0450-00000	4,510	324	0.01%	99.80%	C	810	2.5
X-0575-20000	4,260	306	0.01%	99.81%		765	2.5
X+0400-17500	4.051	291	0.01%	99.82%		728	2.5
X-0675-12500	3,786	272	0.01%	99.83%		680	2.5
X+0500-00000	3,758	270	0.01%	99.84%		675	2.5
X-0625-17500	3,396	244	0.01%	99.85%		610	2.5
X-0775-02500	3,132	225	0.01%	99.86%	C	563	2.5
X+0425-00000	2,185	157	0.01%	99.86%		393	2.5
X+0450-05000	2,088	150	0.01%	99.87%	C	375	2.5
X+0600-00000	1 949	140	0.01%	99.87%		350	2.5

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Items code	Annual Sale value ($)	Quantity on Monthly sale	% of Annual Sale	% of Accumulate annual Sale	Class	Safety stock	Target coverage sale
7+0550-00000	1,921	1 38	0.01%	99.88%	C	345	2.5
X+0475-00000	1,615	116	0.00%	99.88%	C	290	2.5
7+0450-10000	1 573	113	0.00%	99.89%	C	283	2.5
X+0500-05000	1,531	110	0.00%	99.89%		275	2.5
X+0500-10000	1,378	99	0.00%	99.90%	C	248	2.5
X+0425-05000	1 ,336	96	0.00%	99.90%	C	240	2.5
7+0425-07500	1,322	95	0.00%	99.90%	C	238	2.5
X-0775-05000	1,100	79	0 00%	99.91%	C	198	2.5
X+0450-07500	974	70	0 00%	99.91%	C	175	2.5
X+0550-05000	960	69	0.00%	99.91%	C	173	2 5
X+0475-05000	905	65	0.00%	99.92%	C	163	2.5
7+0475-07500	905	65	0.00%	99.92%	C	163	2.5
7+0450-15000	821	59	0.00%	99.92%	C	1 48	2.5
7+0525-05000	793	57	0.00%	99.92%	C	143	2.5
7+0525-07500	793	57	0 00%	99.92%	C	143	2.5
7+0600-05000	780	56	0.00%	99.93%	C	140	2.5
7+0525-00000	752	54	0.00%	99.93%	C	135	2.5
7-0750-07500	738	53	0.00%	99.93%	C	133	2.5
7+0550-10000	724	52	0.00%	99.93%	C	130	2.5
7+0600-10000	724	52	0.00%	99.93%	C	130	2.5
7+0425-10000	710	51	0.00%	99.94%	C	128	2.5
X+0500-15000	710	51	0.00%	99.94%	C	128	2.5
X+0425-12500	682	49	0 00%	99.94%	C	123	2.5
X+0500-07500	682	49	0.00%	99.94%	C	123	2.5
X+0425-02500	626	45	0.00%	99.94%	C	113	2.5
7+0475-10000	626	45	0.00%	99.95%	C	113	2.5
X+0550-15000	599	43	0.00%	99.95%	C	108	2.5
7-0725-10000	599	43	0.00%	99.95%	C	108	2.5
7+0600-15000	585	42	0.00%	99.95%	C	105	2.5
X+0575-00000	571	41	0 00%	99.95%	C	103	2.5
7-0750-10000	571	41	0.00%	99.95%	C	103	2.5
X+0500-20000	529	38	0.00%	99.96%	C......	95	2.5
7+0525-10000	515	37	0.00%	99.96%	C......	93	2.5
7+0575-07500	515	37	0.00%	99.96%		93	2.5
7-0800-07500	515	37	0.00%	99.96%	C	93	2.5
7+0475-15000	501	36	0.00%	99.96%	C	90	2.5
X-0800-05000	501	36	0.00%	99.96%	C	90	2.5
X+0450-20000	487	35	0.00%	99.96%	C	88	2.5
7+0450-02500	459	33	0.00%	99.96%	C	83	2.5
7+0550-07500	459	33	0.00%	99.97%	C	83	2.5
7+0575-05000	459	33	0.00%	99.97%	C	83	2.5
X+0450-12500	445	32	0.00%	99.97%	C	80	2.5
7+0500-12500	445	32	0.00%	99.97%	C	80	2.5
X-0800-02500	445	32	0.00%	99.97%	C	80	2.5
7+0475-12500	432	31	0.00%	99.97%	C	78	2.5
7+0500-02500	432	31	0.00%	99.97%	C	78	2.5
X+0425-15000	418	30	0.00%	99.97%	C	75	2.5
7+0525-12500	418	30	0.00%	99.98%	C	75	2.5
7+0600-20000	418	30	0.00%	99.98%	C	75	2.5
X+0550-20000	404	29	0.00%	99.98%	C	73	2.5
7-0775-07500	404	29	0.00%	99.98%	C	73	2.5
X+0475-02500	390	28	0.00%	99.98%	C	70	2.5
X+0550-12500	390	28	0.00%	99.98%	C	70	2.5
7+0425-17500	376	27	0.00%	99.98%	C	68	2.5
7+0450-17500	376	27	0.00%	99.98%	C	68	2.5
7+0475-17500	376	27	0.00%	99.98%	C	68	2.5
X+0500-17500	376	27	0.00%	99.99%	C	68	2.5
7+0475-20000	348	25	0.00%	99.99%	C	63	2.5
7-0775-10000	348	25	0.00%	99.99%	C	63	2.5
X+0425-20000	320	23	0.00%	99.99%	C	58	2.5
X+0575-10000	320	23	0.00%	99.99%	C	58	2.5
X+0575-12500	320	23	0.00%	99.99%	C	58	2.5
7-0800-10000	306	22	0.00%	99.99%	C	55	2.5
X+0525-15000	292	21	0.00%	99.99%	C	53	2.5
7+0525-17500	292	21	0.00%	99.99%	C	53	2.5
7+0525-02500	264	19	0.00%	99.99%	C	48	2.5
X+0525-20000	264	19	0.00%	99.99%	C	48	2.5
X+0600-12500	264	19	0.00%	99.99%	C	48	2.5
X+0550-17500	251	18	0.00%	100.00%	C	45	2.5
7+0575-17500	251	18	0.00%	100.00%	C	45	2.5
7+0600-07500	251	18	0.00%	100.00%	C	45	2.5
7+0550-02500	237	17	0.00%	100.00%	C	43	2.5
X+0600-02500	209	15	0.00%	100.00%	C	38	2.5
7+0575-20000	195	14	0.00%	100.00%	C	35	2.5
7+0575-02500	181	13	0.00%	100.00%	C	33	2.5
7+0575-15000	181	13	0.00%	100.00%	C	33	2.5
X+0600-17500	181	13	0.00%	100.00%	C	33	2.5
Total	7,289,486						

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APPENDIX E

The 80% items of obsolescence

Items code	Quantity on Monthly sale A (A)	% of Annual Sale	% of Accumulate annual Sale	Class	Ending inventory on Dec'09 (B)	Cost of Obsolescence	Average daily sale_As-Is (C) C=A/30	Days of supply_As-I (days) D=B/C
X-0525-17500	415	0.02%	99.61%	C	5,462	12,555	14	395
X-0475-02500	3,064	0.12%	88.62%	C	9,416	12,135	102	92
X-0525-02500	1 925	0.07%	94.01%	C	8,659	12,105	64	135
X-0475-17500	701	0.03%	98.78%	C	6 570	11,732	23	281
X-0525-15000	546	0.02%	99.25%	C	7,098	11,679	18	390
X-0500-02500	2,348	0.09%	91.40%	C	9520	11,611	78	122
X-0550-02500	1,723	0.07%	94.79%	C	8,478	11,068	57	148
X-0400-02500	4,914	0.19%	80.86%	C	12,294	10,555	164	75
X+0125-07500	4,741	0.18%	81.78%	C	15,677	10,508	158	99
X-0425-20000	572	0.02%	99.18%	C	5,543	10,261	19	291
X-0500-17500	644	0.02%	98.86%	C	5,417	10,258	21	252
X-0550-15000	608	0.02%	99.02%	C	6,306	8,246	20	311
X-0100-17500	2,166	0.08%	92.61%	C	8,194	8,100	72	113
X-0425-132500	4,606	0.18%	82.50%	C	9,455	7,426	154	62
X-0325-17500	1,319	0.05%	96.61%	C	10,244	7,190	44	233
X-0275-10000	5,027	0.19%	80.48%	C	12,761	7,004	168	76
X-0350-15000	2,237	0.09%	92.02%	C	7,098	7,070	75	95
X-0200-20000	1,995	0.08%	93.56%	C	5,750	6,987	67	86
X-0775-02500	225	0.01%	99.86%	C	4,434	6,792	8	591
X-0450-17500	751	0.03%	98.65%	C	6,157	6,679	25	246
X+0025-17500	2,219	0.09%	92.10%	C	8,994	6,536	74	122
X-0575-02500	1,282	0.05%	96.86%	C	7,918	6,612	43	185
X+0150-02500	5,097	0.20%	80.29%	C	20,062	6,564	170	118
X-0575-12500	646	0.02%	98.83%	C	6,488	6,460	22	301
X-0200-12500	4,427	0.17%	83.36%	C	6,157	6,430	148	42
X-0300-20000	1,484	0.06%	96.02%	C	6,211	6,373	49	126
X-0750-02500	347	0.01%	99.74%	C	5,370	6,317	12	464
X-0450-20000	625	0.02%	98.88%	C	4,630	6,290	21	222
X-0325-20000	1,145	0.04%	97.38%	C	7,939	6,249	38	208
X-0250-20000	1,505	0.06%	95.79%	C	6,511	6,227	50	130
X-0125-15000	2,974	0.11%	89.08%	C	7,022	6,219	99	71
X-0300-17500	1,626	0.06%	95.50%	C	7,098	6,184	54	131
X-0250-15000	2,783	0.11%	89.74%	C	7,697	6,011	93	83
X-0225-17500	1,710	0.07%	94.92%	C	10,445	6,010	57	183
X+0200-02500	4,260	0.16%	83.85%	C	15,634	5,988	142	110
X-0600-02500	1,035	0.04%	97.85%	C	6,716	5,940	35	195
X-0450-02500	3,705	0.14%	85.65%	C	11,886	5,923	124	96
X-0675-02500	499	0.02%	99.37%	C	5,559	5,744	17	334
X-0275-12500	3,449	0.13%	86.88%	C	9,067	5,721	115	79
X-0400-10000	4,242	0.16%	84.02%	C	8,495	5,709	141	60
X-0250-12500	3,708	0.14%	85.51%	C	7,681	5,628	124	62
X+0050-17500	2,275	0.09%	91.76%	C	7,297	5,595	76	96
X-0475-20000	501	0.02%	99.33%	C	4,458	5,588	17	267
X+0075-12500	3,763	0.14%	85.23%	C	9,084	5553	125	72
X-0550-17500	443	0.02%	99.55%	C	4,338	5,462	15	294
X+0125-15000	1,912	0.07%	94.16%	C	6,574	5,432	64	103
X+0050-15000	3,533	0.14%	86.35%	C	8,029	5,424	118	68

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Items code	Quantity on Monthly sale A	% of Annual Sale	% of Accumulate annual Sale	Class	Ending inventory on Dec'09	Cost of Obsolescence	Average daily sale As I	Days of supply As Is
	(A)				(10		≈A/3	D=B/C
X-0350-20000	1 138	0.04%	97.55%	C	7,829	5,391	38	206
X-0575-07500	1,300	0.05%	96.76%	C	6,358	5,337	43	147
X-0600-12500	610	0.02%	99.00%	C	5,947	5,319	20	292
X-0625-02500	778	0.03%	98.50%	C	5,838	5,317	26	225
X-0525-10000	1,118	0.04%	97.68%	C	5,690	5,308	37	153
X-0650-07500	891	0.03%	98.17%	C	4,831	5,301	30	163
X+0025-15000	3,470	0.13%	86.61%	C	9,778	5,298	116	85
X-0375-12500	2,641	0.10%	90.16%	C	7,949	5,269	88	90
X-0275-20000	1,236	0.05%	97.19%	C	5,755	5,251	41	140
X-0325-10000	4,793	0.18%	81.60%	C	11,084	5,246	160	69
X-0275-17500	1,460	0.06%	96.13%	C	8,307	5,225	49	171
X-0525-20000	457	0.02%	99.49%	C	3,289	5,216	15	216
X-0125-20000	1,785	0.07%	94.72%	C	6,068	5,133	60	102
X+0325-00000	4,568	0.18%	82.67%	C	15,474	5,123	152	102
X+0350-02500	1,208	0.05%	97.29%	C	6,448	5,123	40	160
X-0600-10000	1,145	0.04%	97.42%	C	7,216	5,122	38	189
X-0150-15000	3,321	0.13%	87.53%	C	10,136	5,098	111	92
X+0050-12500	4,794	0.18%	81.42%	C	12,781	5,075	160	80
X-0175-20000	1,548	0.06%	95.62%	C	6,859	5,049	52	133
X-0475-12500	1,659	0.06%	95.24%	C	8,689	5,027	55	157
X-0500-15000	880	0.03%	98.21%	C	5,829	5,014	29	199
X-0775-00000	688	0.03%	98.81%	C	5,842	5,004	23	255
X-0575-05000	2,015	0.08%	93.40%	C	5,400	4,989	67	80
X-0425-12500	2,202	0.08%	92.27%	C	6,073	4,959	73	83
X-0325-12500	2,940	0.11%	89.31%	C	9,069	4,957	98	93
X+0125-17500	1,273	0.05%	96.91%	C	5,651	4,952	42	133
X+0325-05000	2,831	0.11%	89.64%	C	6,239	4,906	94	66
X+0250-12500	1,497	0.06%	95.85%	C	8,942	4,896	50	179
X-0425-17500	1,122	0.04%	97.64%	C	7,416	4,834	37	198
X+0325-17500	473	0.02%	99.44%	C	4,748	4,821	16	301
X-0725-02500	339	0.01%	99.77%	C	5,473	4,814	11	484
X-0200-17500	2,035	0.08%	93.09%	C	7,945	4,770	68	117
X+0075-15000	2,743	0.11%	89.85%	C	6,417	4,760	91	70
X-0450-15000	1,654	0.06%	95.31%	C	6,021	4,743	55	109
X-0050-15000	4,450	0.17%	83.19%	C	11,922	4,703	148	80
X+0250-02500	3,339	0.13%	87.40%	C	10,414	4,685	111	94
X-0175-12500	4,287	0.16%	83.69%	C	8,606	4,648	143	60
X+0025-12500	4,705	0.18%	81.97%	C	13,168	4,612	157	84
X-0225-15000	2,373	0.09%	91.13%	C	7,119	4,602	79	90
X+0050-20000	2,257	0.09%	91.84%	C	6,976	4,590	75	93
X+0175-07500	3,871	0.15%	84.94%	C	17,407	4,587	129	135
X+0025-20000	1,868	0.07%	94.37%	C	6,479	4,562	62	104
X-0500-10000	2,547	0.10%	90.75%	C	7,017	4,524	85	83
X-0600-20000	480	0.02%	99.40%	C	2,869	4,512	16	179
X+0200-07500	3,948	0.15%	84.64%	C	12,220	4,507	132	93
X-0300-12500	3,600	0.14%	86.08%	C	7,028	4,504	120	59
X+0150-12500	2,348	0.09%	91.31%	C	8,030	4,499	78	103
X-0350-12500	2,976	0.11%	88.97%	C	7,763	4,478	99	78
X-0175-15000	2,873	0.11%	89.42%	C	8,281	4,478	96	86
X-0375-20000	993	0.04%	97.93%	C	8,720	4,383	33	263
X-0625-05000	1,259	0.05%	97.00%	C	4,180	4,343	42	100
X-0550-12500	815	0.03%	98.41%	C	5,421	4,330	27	200
X-0075-15000	3,368	0.13%	87.27%	C	11,939	4,315	112	106
X-0625-10000	618	0.02%	98.93%	C	3,317	4,307	21	161
X-0425-15000	1,600	0.06%	95.56%	C	6,448	4,298	53	121
X-0225-20000	1,486	0.06%	95.96%	C	4,396	4,293	50	89
X-0575-20000	306	0.01%	99.81%	C	3,812	4,285	10	374
X-0525-12500	879	0.03%	98.24%	C	5,215	4,265	29	178
X-0625-00000	2,162	0.08%	92.69%	C	5,730	4,263	72	80
X-0350-10000	4,811	0.18%	81.23%	C	9,459	4,247	160	59
X-0350-17500	1,300	0.05%	96.71%	C	6,611	4,237	43	153
X-0575-17500	339	0.01%	99.76%	C	4,266	4,237	11	378
X-0500-20000	535	0.02%	99.29%	C	4,101	4,154	18	230
X-0075-17500	2,314	0.09%	91.58%	C	5,849	4,136	77	76
X+0325-02500	1,528	0.06%	95.68%	C	7,032	4,134	51	138
X-0500-07500	3,305	0.13%	87.78%	C	10,478	4,119	110	95
X-0475-15000	874	0.03%	98.31%	C	5,877	4,107	29	202
X+0275-12500	1,200	0.05%	97.33%	C	5,534	4,071	40	138
X-0325-15000	2,093	0.08%	93.01%	C	7,208	4,058	70	103
X-0025-20000	2,212	0.08%	92.19%	C	10,454	4,049	74	142

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Items code	Quantity on Monthly sale A	% of Annual Sale	% of Accumulate annual Sale	Class	Ending inventory on Dec'09	Cost a Obsolescence	Average daily sale As-Is (t)	Days of supply, As (days)
X-0575-15000	430	0.02%	99.56%	C	3,880	4,001	14	271
X+0300-02500	2,199	0.08%	92.35%	C	8,821	3,986	73	120
X+0125-20000	1,328	0.05%	96.51%	C	5,686	3,916	44	128
X-0550-05000	3,424	0.13%	87.01%	C	8,696	3,848	114	76
X-0475-07500	3,484	0.13%	86.48%	C	7,820	3,830	116	67
X-0050-17500	2,597	0.10%	90.46%	C	6,845	3,807	87	79
X-0525-05000	3,469	0.13%	86.75%	C	10,338	3,802	116	89
X-0650-02500	619	0.02%	98.91%	C	5,047	3,785	21	245
X-0150-20000	1 533	0.07%	94.66%	C	6,444	3,775	61	105
X+0200-17500	1 ,113	0.04%	97.77%	C	7,126	3,760	37	192
X+0375-02500	772	0.03%	98.56%	C	7,239	3,744	26	281
X-0475-10000	2,344	0.09%	91.49%	C	6,482	3,735	78	83
X+0200-12500	1 592	0.07%	94.30%	C	7,818	3,729	63	124
X-0100-15000	3,729	0.14%	85.37%	C	7,371	3,722	124	59
X+0325-20000	398	0.02%	99.69%	C	4,129	3,711	13	311
X-0150-17500	2,104	0.08%	92.93%	C	6,791	3,702	70	97
X+0350-20000	547	0.02%	99.23%	C	3,702	3,697	18	203
7+0075-17500	1,892	0.07%	94.23%	C	6,489	3,662	63	103
X-0275-15000	2,153	0.08%	92.77%	C	6,300	3,661	72	88
X+0200-10000	3,114	0.12%	88.39%	C	7,754	3,589	104	75
X+0200-15000	1,965	0.08%	93.94%	C	7,378	3,498	66	113
X+0125-10000	3,379	0.13%	87.14%	C	7,926	3,458	113	70
7-0550-10000	1,328	0.05%	96.56%	C	3,814	3,457	44	86
X-0800-00000	878	0.03%	98.28%	C	3,740	3,435	29	128
X+0150-20000	1,489	0.06%	95.91%	C	5,348	3,433	50	108
X-0700-02500	468	0.02%	99.46%	C	4,760	3,402	16	305
X-0125-12500	5,016	0.19%	80.67%	C	7,927	3,377	167	47
X-0675-05000	894	0.03%	98.14%	C	3,751	3,344	30	126
X+0275-17500	536	0.02%	99.27%	C	3,993	3,327	18	223
X-0675-00000	1,510	0.06%	95.73%	C	7,150	3,325	50	142
X-0550-20000	410	0.02%	99.64%	C	3,936	3,262	14	288
X-0600-07500	1,311	0.05%	96.66%	C	5,390	3,247	44	123
X-0650-10000	705	0.03%	98.76%	C	2,474	3,219	24	105
X-0725-00000	1,106	0.04%	97.81%	C	4,602	3,201	37	125
X-0250-17500	1,627	0.06%	95.43%	C	6,368	3,196	54	117
X+0200-20000	1,974	0.08%	93.78%	C	6,258	3,193	66	95
X+0100-12500	3,552	0.14%	86.21%	C	7,990	3,176	118	67
X+0350-05000	2,956	0.11%	89.20%	C	5,859	3,169	99	59
X+0375-15000	449	0.02%	99.53%	C	6,094	3,140	15	407
X-0425-10000	3,181	0.12%	88.03%	C	6,440	3,138	106	61
7+0250-17500	714	0.03%	98.73%	C	5,360	3,138	24	225
7-0300-15000	2,451	0.09%	91.04%	C	10,426	3,125	82	128
7+0225-15000	1,238	0.05%	97.15%	C	7,704	3,110	41	187
7+0225-02500	3,665	0.14%	85.94%	C	11 ,846	3,105	122	97
X-0750-00000	1 ,135	0.04%	97.60%	C	6,836	3,076	38	181
7+0375-17500	420	0.02%	99.59%	C	4502	3,075	14	322
7+0275-15000	872	0.03%	98.34%	C	6,069	3,058	29	209
7-0375-17500	1,115	0.04%	97.72%	C	7,574	3,038	37	204
7-0450-12500	2,017	0.08%	93.33%	C	5,822	3,033	67	87
7-0625-17500	244	0.01%	99.85%	C	2,674	3,032	8	329
7-0375-10000	4,069	0.16%	84.33%	C	10,463	3,022	136	77
7+0175-10000	2,831	0.11%	89.53%	C	6,934	3,012	94	73
7-0125-17500	1,988	0.08%	93.63%	C	7,019	3,000	66	106
7-0400-20000	1,141	0.04%	97.51%	C	5,538	2,993	38	146
7+0325-10000	1,287	0.05%	96.81%	C	5,164	2,988	43	120
7-0150-12500	4,888	0.19%	81.05%	C	10,515	2,969	163	65
7+0275-02500	2,666	0.10%	90.06%	C	8,929	2,967	89	100
7+0150-10000	3,703	0.14%	85.80%	C	9,162	2,944	123	74
7-0150-17500	1,386	0.05%	96.40%	C	5,390	2,937	46	117
7+0225-07500	3,126	0.12%	88.15%	C	8,291	2,935	104	80
7+0300-20000	754	0.03%	98.62%	C	4,036	2,866	25	161
7-0200-15000	3,027	0.12%	88.74%	C	8,608	2,851	101	85
7+0325-15000	606	0.02%	99.05%	C	4,361	2,851	20	216
7-0175-17500	2,025	0.08%	93.17%	C	8,379	2,837	68	124

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Items code	Quantity on monthly sale A	% of Annual Sale	% of Accumulate annual Sale	Class	Ending inventory on Dec'09	Cost of Obsolescence	Average daily sale As-Is ($)	Da of supply As Is (days)
X-0600-05000	1,966	0.08%	93.86%	C	5,216	2,814	66	80
X-0675-10000	459	0.02%	99.48%	C	3,066	2,814	15	200
X+0375-00000	3,018	0.12%	88.85%	C	12,678	2,806	101	126
X-0025-17500	2,498	0.10%	90.95%	C	9598	2791	83	115
X+0175-17500	1,461	0.06%	96.08%	C	7,143	2,784	49	147
X+0350-07500	1,702	0.07%	94.99%	C	3,553	2,769	57	63
X-0400-15000	1,916	0.07%	94.08%	C	5,946	2,744	64	93
X-0625-07500	905	0.03%	98.11%	C	3,346	2,731	30	111
X-0675-07500	604	0.02%	99.09%	C	3,689	2,723	20	183
X+0150-07500	4,183	0.16%	84.18%	C	16,661	2,711	139	119
X-0650-00000	2,253	0.09%	91.93%	C	5,952	2,691	75	79
X+0175-12500	1,996	0.08%	93.48%	C	7,730	2,676	67	116
X+0250-20000	776	0.03%	98.53%	C	4,055	2,648	26	157
X-0600-15000	499	0.02%	99.35%	C	3,717	2,623	17	223
X-0550-07500	1,653	0.06%	95.37%	C	6,708	2,612	55	122
X-0500-12500	1,144	0.04%	97.46%	C	4,821	2,602	38	126
X-0400-17500	1,246	0.05%	97.05%	C	5,545	2,580	42	134
X-0650-05000	1,244	0.05%	97.10%	C	3,888	2,570	41	94
X+0175-20000	922	0.04%	98.07%	C	6,163	2,560	31	201
X+0100-17500	1,666	0.06%	95.18%	C	5,250	2,549	56	95
X+0225-17500	801	0.03%	98.47%	C	5,438	2,492	27	204
X-0600-17500	379	0.01%	99.72%	C	3,486	2,490	13	276
X-0450-07500	4,459	0.17%	83.02%	C	10,545	2,472	149	71
X+0275-20000	486	0.02%	99.39%	C	4,617	2,472	16	285
X+0300-15000	1,260	0.05%	96.96%	C	5,903	2,471	42	141
X-0375-15000	1,691	0.06%	95.05%	C	6,521	2,436	56	116
X+0250-15000	1,392	0.05%	96.35%	C	6,445	2,434	46	139
X-0750-05000	600	0.02%	99.12%	C	2,690	2,406	20	135
X+0075-20000	1,689	0.06%	95.12%	C	5,540	2,373	56	98
X-0650-15000	386	0.01%	99.70%	C	2,203	2,326	13	171
X+0225-10000	2,140	0.08%	92.85%	C	7,227	2,291	71	101
X-0575-00000	5,166	0.20%	80.09%	C	14,612	2,280	172	85
X+0375-07500	1,363	0.05%	96.46%	C	5,920	2,260	45	130
X+0100-15000	2,548	0.10%	90.65%	C	7,764	2,251	85	91
X-0575-10000	954	0.04%	98.00%	C	5,488	2,227	32	173
X-0700-00000	2,365	0.09%	91.22%	C	7,325	2,202	79	93
X+0375-12500	605	0.02%	99.07%	C	6,297	2,193	20	312
X-0700-05000	859	0.03%	98.38%	C	4,515	2,168	29	158
X-0700-10000	475	0.02%	99.42%	C	3,684	2,140	16	233
X+0175-15000	1,712	0.07%	94.86%	C	7,941	2,130	57	139
X+0125-12500	3,318	0.13%	87.65%	C	6,762	2,120	111	61
X+0250-10000	2,555	0.10%	90.56%	C	6,439	2,117	85	76
X+0100-20000	1,847	0.07%	94.44%	C	5,732	2,112	62	93
X+0150-15000	3,124	0.12%	88.27%	C	8,270	2,095	104	79
X+0400-15000	582	0.02%	99.14%	C	4,240	2,061	19	219
X-0100-20000	2,193	0.08%	92.44%	C	6,420	2,019	73	88
X+0350-15000	743	0.03%	98.67%	C	4,461	1,989	25	180
X-0525-07500	2,297	0.09%	91.67%	C	7,858	1,974	77	103
X+0300-05000	4,639	0.18%	82.32%	C	9,822	1,966	155	64
X-0625-15000	327	0.01%	99.78%	C	2,402	1,919	11	220
X-0675-12500	272	0.01%	99.83%	C	2,312	1,900	9	255
X+0375-05000	1,839	0.07%	94.51%	C	4,983	1,875	61	81
X+0350-12500	736	0.03%	98.70%	C	5,108	1,846	25	208
X-0075-20000	2,023	0.08%	93.25%	C	7,439	1,833	67	110
X+0300-12500	1,208	0.05%	97.24%	C	5,422	1,822	40	135
X+0225-12500	1,409	0.05%	96.30%	C	7,004	1,805	47	149
X-0625-12500	430	0.02%	99.58%	C	1,714	1,790	14	120
X-0700-07500	571	0.02%	99.21%	C	5,051	1,714	19	265

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Items code	Quantity on Monthly sale A	% Annual Sale	% of Accumulate annual Sale	Class	Ending inventory on Dec'09	Cost of Obsolescence	Average daily sale As-Is ($)	Days Of supply As-Is (days)
X+0300-07500	2,634	0.10%	90.26%	C	6,111	1,709	88	70
X-0450-10000	3,076	0.12%	88 51%	C	7,979	1,692	103	78
X+0225-20000	756	0.03%	98.59%	C	5,995	1,687	25	238
X+0400-07500	1,017	0.04%	97.89%	C	4,481	1,657	34	132
X+0350-10000	1,455	0.06%	96.19%	C	5,317	1,646	49	110
X+0400-05000	1,433	0.06%	96.24%	C	5,772	1,601	48	121
X+0275-07500	2,706	0.10%	89.95%	C	6559	1,599	90	73
X-0025-15000	3,828	0.15%	85.08%	C	11 572	1,576	128	91
X+0400-12500	612	0.02%	98.98%	C	6,314	1,473	20	310
X+0300-17500	533	0.02%	99.31%	C	3,313	1,461	18	186
X-0225-12500	3,908	0.15%	84.79%	C	9586	1,402	130	74
X+0375-20000	367	0.01%	99.73%	C	3,924	1,402	12	321
X+0400-10000	929	0.04%	98.04%	C	4,653	1,400	31	150
X+0350-17500	409	0.02%	99.66%	C	2513	1,328	14	192
X-0725-05000	577	0.02%	99.16%	C	2,945	1,325	19	153
X-0725-10000	43	0.00%	99.95%	C	1,589	1,305	1	1,109
X+0250-07500	3,241	0.12%	87 91%	C	7,564	1,244	108	70
X+0275-10000	1,836	0.07%	94.59%	C	6,602	1,199	61	108
X-0650-12500	401	0.02%	99.67%	C	1,493	1,196	13	112
X+0325-07500	1 582	0.08%	93 71%	C	4,822	1,194	66	73
X+0400-02500	614	0.02%	98.95%	C	7,322	1,176	20	358
X+0325-12500	808	0.03%	98.44%	C	3,429	1,167	27	127
X+0275-05000	4,497	0.17%	82.85%	C	10,911	1,146	150	73
X-0400-12500	2,611	0.10%	90.36%	C	8,000	1,108	87	92
X+0375-10000	957	0.04%	97.96%	C	5,361	1,031	32	168
X-0725-07500	454	0.02%	99 51%	C	3,863	1,011	15	255
X-0050-20000	2,539	0.10%	90.85%	C	6,374	947	85	75
X+0400-20000	414	0.02%	99.63%	C	2,688	797	14	195
X+0400-17500	291	0.01%	99.82%	C	5,461	784	10	563
X-0750-10000	41	0.00%	99.95%	C	1,174	747	1	859
X-0800-05000	36	0.00%	99.96%	C	1,206	733	1	1,005
X-0800-07500	37	0.00%	99.96%	C	810	729	1	657
X-0775-10000	25	0.00%	99.99%	C	770	711	1	924
X-0425-07500	4,674	0.18%	82.14%	C	8,860	651	156	57
X-0800-02500	32	0.00%	99.97%	C	931	635	1	873
X-0775-07500	29	0.00%	99.98%	C	1,026	605	1	1,061
X-0800-10000	22	0.00%	99.99%	C	755	603	1	1,030
X+0300-10000	2,188	0.08%	92.52%	C	8,289	575	73	114
X+0400-00000	3,956	0.15%	84.49%	C	8,766	518	132	66
X+0175-02500	4,317	0.17%	83.53%	C	18,178	397	144	126
X-0775-05000	79	0.00%	99.91%	C	1,034	321	3	393
X-0750-07500	53	0.00%	99.93%	C	958	210	2	542
X+0450-05000	150	0.01%	99.87%	C	880	92	5	176
X+0550-12500	28	0.00%	99.98%	C	787	83	1	843
X+0525-12500	30	0.00%	99.98%	C	1,070	70	1	1,070
X+0525-15000	21	000%	99.99%	C	846	67	1	1,209
X+0425-05000	96	0.00%	99.90%	C	1,060	62	3	331
X+0525-05000	57	0.00%	99.92%	C	965	62	2	508
X+0550-05000	69	0.00%	99.91%	C	867	60	2	377
X+0600-05000	56	0.00%	99.93%	C	741	60	2	397
X+0575-05000	33	0.00%	99.97%	C	873	60	1	794
X+0475-05000	65	0.00%	99.92%	C	754	54	2	348
X+0575-12500	23	0.00%	99.99%	C	825	52	1	1,076
X+0500-05000	110	0.00%	99.89%	C	992	50	4	271
X+0500-12500	32	0.00%	99.97%	C	918	50	1	861
X+0500-17500	27	0.00%	99.99%	C	1,075	50	1	1,194
33+0525-02500	19	0.00%	99.99%	C	1,067	49	1	1,685

Items code	Quantity on Monthly sale A (A)	% of Annual Sale	% of Accumulate annual Sale	Class	Ending inventory on Dec'09 (")	Cost of	Average daily sal As-Is C =A/3	Days of supply As-Is D=B/C
X+0500-00000	270	0.01%	99.84%	C	722	47	9	80
X+0425-07500	95	0.00%	99.90%	C	724	47	3	229
X+0600-00000	140	0.01%	99.87%	C	843	44	5	181
X+0525-20000	19	0.00%	99.99%	C	915	44	1	1,445
X+0425-10000	51	0.00%	99.94%	C	1,080	40	2	635
X+0575-07500	37	0.00%	99.96%	C	800	40	1	649
X+0550-02500	17	0.00%	100.00%	C	1,125	40	1	1,985
X+0575-20000	14	0.00%	100.00%	C	904	39	0	1,937
X+0575-00000	41	0.00%	99.95%	C	1,330	37	1	973
X+0600-12500	19	0.00%	99.99%	C	729	37	1	1,151
X+0475-00000	116	0.00%	99.88%	C	659	34	4	170
X+0600-02500	15	0.00%	100.00%	C	956	34	1	1,912
X+0500-02500	31	0.00%	99.97%	C	1,107	32	1	1,071
X+0525-07500	57	0.00%	99.92%	C	916	30	2	482
X+0475-12500	31	0.00%	99.97%	C	669	30	1	647
X+0500-10000	99	0.00%	99.90%	C	764	29	3	232
X+0450-07500	70	0.00%	99.91%	C	642	29	2	275
X+0475-07500	65	0.00%	99.92%	C	638	29	2	294
X+0450-15000	59	0.00%	99.92%	C	916	29	2	466
X+0600-10000	52	0.00%	99.93%	C	791	29	2	456
X+0500-20000	38	0.00%	99.96%	C	843	29	1	666
X+0450-02500	33	0.00%	99.96%	C	925	29	1	841
X+0550-20000	29	0.00%	99.98%	C	812	29	1	840
X+0475-20000	25	0.00%	99.99%	C	526	29	1	631
X+0600-17500	13	0.00%	100.00%	C	840	29	0	1,938
X+0425-12500	49	0.00%	99.94%	C	738	27	2	452
X+0550-15000	43	0.00%	99.95%	C	862	27	1	601
X+0575-10000	23	0.00%	99.99%	C	621	27	1	810
X+0425-00000	157	0.01%	99.86%	C	1 560	25	5	298
X+0500-15000	51	0.00%	99.94%	C	791	25	2	465
X+0450-12500	32	0.00%	99.97%	C	658	25	1	617
X+0425-17500	27	0.00%	99.98%	C	985	25	1	1,094
X+0550-17500	18	0.00%	100.00%	C	827	25	1	1,378
X+0600-07500	18	0.00%	100.00%	C	805	25	1	1,342
X+0575-15000	13	0.00%	100.00%	C	664	25	0	1,532
X+0450-10000	113	0.00%	99.89%	C	742	24	4	197
X+0425-15000	30	0.00%	99.97%	C	703	24	1	703
X+0450-17500	27	0.00%	99.98%	C	711	24	1	790
X+0525-17500	21	0.00%	99.99%	C	677	24	1	967
X+0575-02500	13	0.00%	100.00%	C	923	24	0	2,130
X+0525-00000	54	0.00%	99.93%	C	1,267	22	2	704
X+0550-10000	52	0.00%	99.93%	C	676	22	2	390
X+0450-20000	35	0.00%	99.96%	C	504	22	1	432
X+0475-17500	27	0.00%	99.98%	C	632	22	1	702
X+0550-00000	138	0.01%	99.88%	C	1,358	19	5	295
X+0600-15000	42	0.00%	99.95%	C	965	19	1	689
X+0600-20000	30	0.00%	99.98%	C	958	19	1	958
X+0475-10000	45	0.00%	99.95%	C	817	17	2	545
X+0425-20000	23	0.00%	99.99%	C	628	17	1	819
X+0475-15000	36	0.00%	99.96%	C	800	15	1	667
X+0450-00000	324	0.01%	99.80%	C	698	14	11	65
X+0500-07500	49	0.00%	99.94%	C	1,031	14	2	631
X+0425-02500	45	0.00%	99.94%	C	1,064	14	2	709
X+0525-10000	37	0.00%	99.96%	C	937	14	1	760
X+0550-07500	33	0.00%	99.97%	C	925	14	1	841
X+0475-02500	28	0.00%	99.98%	C	1,436	9	1	1,539
X+0575-17500	18	0.00%	100.00%	C	844	12	1	1,407
	523,670				1,946,599	1,078,754	17,456	112